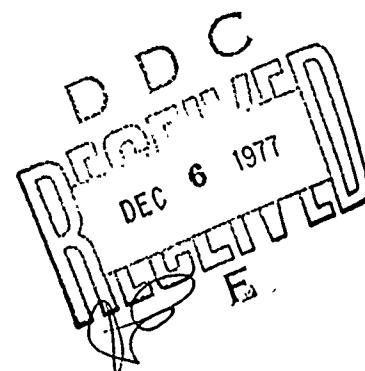


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THESIS REPORT

EXPERIMENTALLY DETERMINED
EFFECTS OF EDUCTOR GEOMETRY ON THE
PERFORMANCE OF EXHAUST GAS EDUCTORS FOR
GAS TURBINE POWERED SHIPS

by

John Peter Harrell, Jr.
September 1977

Thesis Advisor:

Paul F. Pucci

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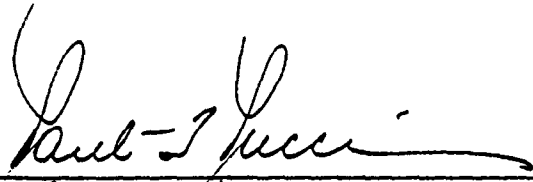
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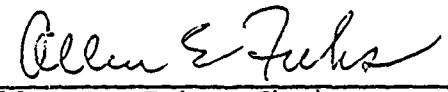
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Experimentally Determined
Effects of Eductor Geometry on the
Performance of Exhaust Gas Eductors for
Gas Turbine Powered Ships

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Submitted in partial fulfillment of the
requirements for the degrees of

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ABSTRACT

Cold flow model tests of exhaust gas eductors with constant area mixing stacks were conducted to evaluate the effects of geometric configuration on eductor performance. Single-nozzle and four-nozzle designs were tested. The other geometric variables were mixing stack length to diameter ratio (L/D), primary nozzle standoff to diameter ratio (S/D), and mixing stack entrance configuration. Non-dimensional parameters governing the flow phenomena are developed from a one-dimensional analysis of a simple eductor system. The eductor performance is evaluated in terms of these non-dimensional parameters. The four-nozzle configurations were found to have better performance than single-nozzle configurations for L/D 's less than eight. The effects of L/D , S/D , and entrance shape on performance were found to be highly interdependent at short L/D 's. Performance for L/D 's greater than four was found to be independent of S/D within the range of S/D 's studied.

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NOMENCLATURE

English Letter Symbols

A	- Area, in ²
AR	- Area Ratio
c	- Sonic velocity, ft/sec
C	- Coefficient of discharge
D	- Diameter, in
f	- Friction factor
Fa	- Thermal expansion factor
F _{fr}	- Wall skin-friction force, lbf/ft ²
g _c	- Proportionality factor in Newton's Second Law, g _c = 32.174 lbm-ft/lbf-sec ²
h	- Enthalpy, Btu/lbm
k	- Ratio of specific heats
K	- Flow coefficient
K _e	- Kinetic energy correction factor
K _m	- Momentum correction factor at the mixing stack exit
K _p	- Momentum correction factor at the primary nozzle exit
L	- Length, in
P	- Pressure, in H ₂ O
P _a	- Atmospheric pressure, in Hg
P _v	- Velocity head, in H ₂ O
R	- Gas constant for Air, 53.34 ft-lbf/lbm-°R
s	- Entropy, Btu/lbm-°R
T	- Absolute temperature, °R

- u - Internal energy, Btu/lbm
- U - Velocity, ft/sec
- v - Specific volume, lbm/ft³
- W - Mass flow rate, lbm/sec
- Y - Expansion factor

Dimensionless Groupings

- A* - Secondary flow area to primary flow area ratio
- M - Mach number
- ΔP^* - Pressure coefficient
- Re - Reynolds number
- T* - Secondary flow absolute temperature to primary flow absolute temperature ratio
- W* - Secondary mass flow rate to primary mass flow rate ratio
- ρ^* - Secondary flow density to primary flow density ratio

Greek Letter Symbols

- μ - Absolute viscosity, lbf-sec/ft²
- ρ - Density, lbm/ft³

Subscripts

- 0 - Section within secondary air plenum
- 1 - Section at primary nozzle exit
- 2 - Section at mixing stack exit
- m - Mixed flow or mixing stack
- or - Orifice
- P - Primary
- s - Secondary

- u - Uptake
- w - Mixing stack inside wall

TABULATED VALUES

- POR - Upstream pressure at the orifice, in H_2O
- DPOR - Orifice pressure drop, in H_2O
- TOR - Orifice temperature, degrees F
- TUPT - Uptake temperature, degrees F
- TAMB - Ambient temperature, degrees F
- PU-PA - Uptake static pressure, in H_2O
- PA-PS - Mixing stack entrance static pressure, in H_2O
- PA-PNZ - Pressure differential across secondary flow nozzles, in H_2O
- W* - Secondary mass flow rate to primary flow rate ratio
- P* - Pressure Coefficient
- T* - Absolute temperature ratio, secondary flow to primary flow
- P*/T* - Dimensionless pressure coefficient
- W*T*.44 - Dimensionless pumping performance
- WP - Primary mass flow rate, lbm/sec
- WS - Secondary mass flow rate, lbm/sec
- UP - Primary flow velocity at nozzle exit, ft/sec
- UM - Average velocity in mixing stack, ft/sec
- UU - Primary flow velocity in uptake, ft/sec
- PMS - Mixing stack static pressure, in H_2O
- PMS* - Non-dimensional mixing stack static pressure
- PTA - Diagonal pressure traverse at mixing stack exit, in H_2O

- PTB - Horizontal pressure traverse at mixing
stack exit, in H_2O
- VA - Diagonal velocity traverse at mixing
stack exit, ft/sec
- VB - Horizontal velocity traverse at mixing
stack exit, ft/sec

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I. INTRODUCTION

The advent of gas turbine engines as prime movers for ships has required several modifications to traditional ship designs of the past to accommodate this lightweight and powerful, yet temperamental power plant. The salt-laden sea air, if ingested unfiltered, can seriously degrade the operating life and performance of the engine. The hot engine exhaust is a potential hazard to both men and mast-mounted equipment as well as an easy target for infrared guided weaponry.

Modern gas turbine powered naval vessels such as the DD-963 class destroyers employ an exhaust gas eductor system to cool the hot gas turbine exhaust by mixing it with cool ambient air before it is discharged out the stack. A schematic diagram of a simple exhaust gas eductor defining eductor nomenclature is pictured in Figure 1.

Three major requirements are placed on eductors in this role. They must induce or pump large volumes of secondary air into the mixing stack of the eductor, they must adequately mix the hot high velocity exhaust gas and the cool low velocity secondary air to reduce the temperature peaks of the exhaust flow, and they must not impose excessive performance penalties on the gas turbine power plant.

Many investigators have examined single-nozzle eductors, but relatively few have done work with multiple-nozzle

eductors. Pucci [1] developed an improved one-dimensional analysis of a single-nozzle eductor system with a constant area mixing stack by combining a one-dimensional flow analysis with an experimentally determined momentum correction factor. He demonstrated that the performance of an eductor is dependent upon the completeness of mixing of primary and secondary flows which is a function of mixing stack length, mixing stack area to primary nozzle area ratio and secondary to primary flow-rate ratio.

Ellin [2] conducted model tests of four-nozzle eductors in shipboard use, as well as tests on several proposed eductor systems. He reported results that agreed with Pucci's findings for single-nozzle eductors but found improved performance with multiple-nozzle eductors. His other major findings were that the uptake Mach number had little effect on non-dimensionalized eductor performance and that the variable having the greatest effect on performance was the mixing stack area to primary nozzle area ratio.

Moss [3] investigated four-nozzle eductor system performance as a function of geometry for a wider range of variables than did Ellin. However, he restricted his configurations tested to those that were feasible for topside exhaust gas eductors. He did not, for instance, investigate mixing stack L/D 's greater than 3.0 because of the weight penalty associated with such configurations in marine applications. He reported an interdependence of nozzle standoff distance and mixing stack L/D as they affected

3
pumping. He also found that the same level of pumping could be attained by either the addition of a conical entrance region to the mixing stack or by manipulation of the nozzle standoff distance without the conical attachment.

It is the purpose of this study to determine the effects of eductor geometry on eductor performance as characterized by the amount of pumping achieved and the degree of mixing that occurs. By varying the eductor geometry over a wide range the general effects of geometry on performance can be deduced. Performance trends, maximums, and crossover points can then indicate areas for further concentrated investigation and add to the overall understanding of eductor performance.

The performance penalty on a gas turbine engine due to the presence of an eductor in the exhaust ducting is due to the back pressure or pressure drop caused by the eductor. The primary variable affecting pressure drop is the ratio of uptake flow area to primary nozzle area, as reported by Ellin [2]. For this study, the ratio was held constant at 3:1, that being consistent with area ratios for eductors in actual use in this application.

Five basic variables were studied: one flow variable and four geometric variables. Three primary flow rates corresponding to nominal uptake Mach numbers of 0.048, 0.068, and 0.082 were used. These flow rates are similar to those found in the uptakes of gas turbine powered ships operating at different power levels.

8 Mixing stack length to diameter ratios (L/D 's) ranging from 2.0 through 11.07 were tested. The physical characteristics of the test facility determined the shortest stack that could be accommodated for each stack entrance geometry.

Nozzle standoff to diameter ratios (S/D 's), as more thoroughly discussed below, were varied to determine their effects on performance.

Three mixing stack entrance region shapes were tested by attaching transition pieces to the mixing stack. The three shapes tested were elliptic, conical, and straight.

The final and most important geometrical variable tested was the primary nozzle. During phase I of the study the eductor was tested with a single primary nozzle while all of the other variables were changed. A summary of the various single-nozzle configurations tested is given in Table I. In phase II, a four-nozzle primary nozzle plate was installed, and the remaining variables were changed to determine their effects on performance. A summary of the various four-nozzle configurations tested is given in Table II.

The results of the eductor tests conducted are reported in terms of non-dimensional parameters developed by Pucci [1] and expanded upon by Ellin [2]. These parameters are derived from an analysis of a one-dimensional simple eductor. Ellin [2] has shown that the same dimensionless parameters

can be derived by using the classical Buckingham π Theorem applied to the variables of the flow.

For the present study, primary air was supplied by a turbo-compressor. The use of this relatively cool primary air had the advantages of a simpler test rig and lower cost than would have been possible with hot primary air. The classical Reynolds analogy postulates that the governing mechanisms for momentum and heat transfer are the same for fluids with Prandtl number near unity in a highly turbulent flow regime such as is found in an eductor mixing stack. For this reason, measurements of the momentum transfer in the cold flow test eductor can be theoretically correlated to the thermal energy transfer between the primary and secondary flows in an actual hot flow gas turbine exhaust eductor.

The secondary air flow in the eductor test facility was measured by placing the eductor within a large plenum. The flow-measurement nozzles in the plenum allowed the flow of secondary air to be controlled and measured without disrupting the flow pattern within the eductor. A characteristic pumping curve was generated by restricting the secondary air flow in sequential increments by plugging the secondary flow nozzles and measuring the plenum vacuum at each step. This characteristic curve was then cast in non-dimensional form and extrapolated, as shown in Figure 2, to the maximum flow point which corresponds to the operating point for an eductor open to the environment.

The degree of mixing in the mixing stack was determined by evaluating the amount of momentum transfer between the primary and secondary flows. The Reynolds analogy then allowed insight into the thermal mixing characteristics of the two flows. The momentum transfer is quantified by the momentum correction factor, K_m , which is determined by measuring the mixing stack exit plane velocity profile. The closer the value of K_m is to unity, the greater the momentum transfer which has taken place, inferring a better mixing of the two air flows and better thermal performance.

A simpler method for evaluating thermal performance involves the value of the peak to average velocity ratio at the mixing stack exit. The evaluation of this parameter involves less approximation since integration of the velocity profile with its inherent drawbacks, is unnecessary. The average velocity can be obtained by applying the continuity equation through the eductor, once the primary and secondary air flow rates have been determined. Again, the closer the value of the peak to average velocity ratio is to unity, the better is the mixing performance of the eductor. This measure of performance is also of greater immediate utility to the designer because he can readily obtain predicted peak to average temperature performance using this data.

Both K_m and the peak to average velocity ratios are presented for the four-nozzle configurations tested, while only the latter is given for single-nozzle eductors.

II. THEORY AND ANALYSIS

Evaluation of the effects of eductor geometry on prototype eductor performance through experimentation with models requires the following: assurance of similitude (geometric, kinematic, and dynamic similarity) between model and prototype; the identification of the dimensionless groupings controlling the flow phenomenon; and a suitable means of data analysis and presentation. Dynamic similarity was maintained by using Mach number similarity to establish the model's primary flow rate. Determination of the dimensionless groupings that govern the flow was accomplished through the analysis of a simple air eductor system. Based on this analysis, an experimental correlation of the non-dimensional parameters was developed and used in presenting and evaluating experimental results.

A. MODELING TECHNIQUES

Dynamic similarity between prototype and model was maintained by duplicating the flow while accounting for differences in fluid properties arising from using relatively cool air rather than hot exhaust gas for the primary flow in the model eductor. For the flow velocities considered, the primary flow through the model eductor is turbulent ($Re \approx 10^5$). Consequently, turbulent momentum exchange is a predominant mechanism over shear interaction, and the kinetic and internal energy terms are more influential on

the flow than are viscous forces. Since Mach number can be shown to represent the square root of the ratio of kinetic energy of a flow to its internal energy, it is a more significant parameter than Reynolds number in describing the primary flow through the uptake.

Similarity of Mach number was therefore used to model the primary flow. Mach number is defined as the ratio of flow velocity to sonic velocity in the medium considered. Sonic velocity, represented by c , can be calculated using the relation

$$c = (g_c kRT)^{0.5}$$

if the fluid is assumed to behave as a perfect gas. Neglecting the minor differences in the ratio of specific heats, k , and the gas constant, R , between the hot exhaust gases of the prototype and the cool air used in the model, Mach number similarity from prototype to model results in the relationship

$$\left(\frac{U_{\text{model}}}{U_{\text{prot.}}} \right) = \left(\frac{T_{\text{model}}}{T_{\text{prot.}}} \right)^{0.5}$$

This relationship was used to arrive at the model's primary flow velocity, thereby creating dynamic similarity between model and actual full scale marine eductors.

Geometric similarity was achieved by holding the ratio of mixing stack area to primary nozzle area, A_m/A_p , constant throughout the study. This ratio is similar to that found in actual shipboard exhaust gas eductors.

B. ONE-DIMENSIONAL ANALYSIS OF A SIMPLE EDUCTOR

The theoretical analysis of an eductor may be approached in two ways. One method attempts to analyze the details of the mixing process of the primary and secondary flows which takes place inside the mixing stack and thereby determines the parameters that describe the flow. This requires an interpretation of the mixing phenomenon, which, when applied to multiple-nozzle systems, becomes extremely complex. The second method, employed in this study, analyzes the overall performance of the eductor system as a unit. Since details of the mixing process are not considered in this method, an analysis of the simple single-nozzle eductor system shown in Figure 3 leads to a determination of the dimensionless groupings governing the flow. The one-dimensional analysis that follows is essentially that of Ellin [2].

The driving or primary fluid, flowing at a rate W_p and at a velocity U_p , discharges into the entrance of the constant area section of the mixing stack, inducing a secondary flow rate of W_s at velocity U_s . The primary and secondary flows are mixed and leave the mixing stack at a flow rate of W_m and a bulk average velocity of U_m .

The one-dimensional flow analysis of the simple eductor system described depends on the simultaneous solution of the equations of continuity, momentum, and energy with an appropriate equation of state and specified boundary conditions.

The following simplifying assumptions are made:

1. Both gas flows are treated as perfect gases with constant specific heats.
2. Steady, incompressible flow throughout the eductor and plenum exists.
3. The flow throughout the eductor is adiabatic. The flow of secondary air from the plenum (at section 0) to the entrance of the mixing stack (at section 1) is isentropic. Irreversible adiabatic mixing occurs between the primary and secondary flows in the mixing stack (between sections 1 and 2).
4. The static pressure distributions across the entrance and exit planes of the mixing stack (at sections 1 and 2) are uniform.
5. At the mixing stack entrance (section 1), the primary flow velocity U_p and temperature T_p are uniform across the primary stream, and the secondary flow velocity U_s and temperature T_s are uniform across the secondary stream; but U_p does not equal U_s , and T_p does not equal T_s .
6. Incomplete mixing of the primary and secondary flows in the mixing stack is accounted for by the

use of a non-dimensional momentum correction factor, K_m , which relates the actual momentum rate to the rate based on the bulk-average velocity and density and by the use of a non-dimensional kinetic energy correction factor, K_e , which relates the actual kinetic energy rate to the rate based on the bulk-average velocity and density.

7. Potential energy differences due to elevation are negligible.
8. Pressure changes P_{so} to P_{si} and P_1 to P_a are small relative to the static pressure so that the gas density is essentially dependent upon temperature (and atmospheric pressure).
9. Wall friction in the mixing stack is accounted for with the conventional pipe friction factor term based on the bulk-average flow velocity U_m and the mixing stack wall area A_w .

The conservation of mass principle for steady state flow yields

$$W_m = W_p + W_s \quad (1)$$

where

$$W_p = \rho_p U_p A_p$$

$$W_s = \rho_s U_s A_s$$

$$W_m = \rho_m U_m A_m \quad (1a)$$

Substituting for W_m , the bulk-average velocity becomes

$$U_m = \frac{W_s + W_p}{\rho_m A_m} \quad (1b)$$

Now, from assumption 1

$$\rho_m = \frac{P_a}{R T_m} \quad (2)$$

where T_m is calculated as the bulk-average temperature for the mixed flow. Applying assumptions 4 and 6, the momentum equation for the flow in the mixing stack may be written

$$K_p \left[\frac{W_p U_p}{g_c} \right]_1 + \left[\frac{W_s U_s}{g_c} \right]_1 + P_1 A_1 = K_m \left[\frac{W_m U_m}{g_c} \right]_2 + P_2 A_2 + F_{fr} \quad (3)$$

with $A_1 = A_2$. The momentum correction factor K_p is introduced to account for a possible non-uniform velocity profile across the primary nozzle exit. It is defined in a manner similar to that of K_m and by assumption 5 is equal to unity but is included here for completeness. The momentum correction factor for the mixing stack exit is defined by the relation

$$K_m = \frac{1}{W_m U_m} \int_0^{A_m} U_2^2 \rho_2 dA \quad (4)$$

The actual variable velocity and a weighted average density at section 2 are used in the integrand. A detailed explanation of the calculation procedure for K_m is given in Appendix A. The wall skin-friction force F_{fr} can be related to the mean velocity by

$$F_{fr} = f A_w \left[\frac{U_m^2 \rho_m}{2 g_c} \right] \quad (5)$$

For turbulent flow, the friction factor may be calculated from the Reynolds number as

$$f = 0.046 (Re_m)^{-0.2}, \quad \text{where } Re_m = \frac{\rho_m U_m D_m}{\mu_m} \quad (6)$$

Applying the conservation of energy principle to the steady flow in the mixing stack with assumption 7

$$W_p \left[h_p + \frac{U_p^2}{2 g_c} \right]_1 + W_s \left[h_s + \frac{U_s^2}{2 g_c} \right]_1 = W_m \left[h_m + K_e \frac{U_m^2}{2 g_c} \right]_2 \quad (7)$$

where K_e is the kinetic energy correction factor defined by the relation

$$K_e = \frac{1}{W_m U_m^2} \int_0^{A_m} U_2^3 \rho_2 dA \quad (8)$$

It may be demonstrated that for the purpose of evaluating the mixed mean flow temperature T_m , the kinetic energy terms may be neglected to yield

$$h_m = \frac{W_p}{W_m} h_p + \frac{W_s}{W_m} h_s \quad (9)$$

where $T_m = \phi(h_m)$ only from assumption 1.

Similarly, the energy equation applied to the flow of secondary air between the plenum entrance and the mixing stack entrance may be reduced to

$$\frac{P_0 - P_1}{\rho_s} = \frac{U_s^2}{2 g_c} \quad (10)$$

The foregoing equations may be combined to yield the vacuum produced by the eductor in the plenum chamber

$$P_a - P_0 = \frac{1}{g_c A_m} \left\{ K_p \frac{W_p^2}{A_p \rho_p} + \frac{W_s^2}{A_s \rho_s} \left[1 - \frac{A_m}{2 A_s} \right] - \frac{W_m^2}{A_m \rho_m} \left[K_m + \frac{f}{2} \frac{A_w}{A_m} \right] \right\} \quad (11)$$

where it is understood that A_p and ρ_p apply to the primary flow at the entrance to the mixing stack (section 1), A_s and ρ_s apply to the secondary flow at this same section, and A_m and ρ_m apply to the mixed flow at the exit of the mixing stack (section 2). P_a is atmospheric pressure and is equal to the pressure at the exit of the mixing stack P_2 . This equation also incorporates the assumption that $(\rho_s)_1 = (\rho_s)_0$ so that ρ_s may be taken as the density of the secondary flow in the plenum.

1. Non-Dimensional Solution of Simple Eductor Analysis

In order to provide the criteria of similarity of flows with geometric similarity, the non-dimensional parameters which govern the flow must be determined. One means of determining these parameters is by normalizing equation (11) which leads to the following terms:

$$\Delta P^* = \frac{\left(\frac{P_s - P_0}{\rho_s} \right)}{\left(\frac{U_p^2}{2 g_c} \right)}$$

a pressure coefficient which compares the "pumped head" $\frac{P_a - P_0}{\rho_s}$ for the secondary flow to the "driving head" $\frac{U_p^2}{2 g_c}$ of the primary flow.

$$W^* = \frac{W_s}{W_p}$$

a flow rate ratio, secondary-to-primary mass flow rate.

$$T^* = \frac{T_s}{T_p}$$

an absolute temperature ratio, secondary-to-primary.

$$\rho^* = \frac{\rho_s}{\rho_p}$$

a flow density ratio. Note that since $P_s = P_p$ and the fluids are perfect gases $\rho^* = \frac{T_p}{T_s} = \frac{1}{T^*}$.

$$A^* = \frac{A_s}{A_p}$$

area ratio of secondary flow area
to primary flow area

$$\frac{A_p}{A_m}$$

area ratio of primary flow area
to mixing stack cross sectional area

$$\frac{A_w}{A_m}$$

area ratio of wall friction area
to mixing stack cross sectional
area

$$K_p$$

momentum correction factor for
primary flow

$$K_m$$

momentum correction factor for
mixed flow

$$f$$

wall friction factor

With these non-dimensional groupings, equation (11) may be
written as

$$\begin{aligned} \frac{\Delta P^*}{T^*} = & 2 \frac{A_p}{A_m} \left\{ \left[K_p - \frac{A_p}{A_m} \beta \right] - W^* (1 + T^*) \frac{A_p}{A_m} \beta \right. \\ & \left. + W^{*2} T^* \left[\frac{1}{A^*} \left(1 - \frac{A_m}{2A^* A_p} \right) \frac{A_p}{A_m} \beta \right] \right\} \quad (11a) \end{aligned}$$

where

$$\beta = \left(K_m + \frac{f}{2} \frac{A_w}{A_m} \right) .$$

For a given eductor geometry, equation (11a) may be expressed in the form

$$\frac{\Delta P^*}{T^*} = C_1 + C_2 W^* (T^* + 1) + C_3 W^{*2} T^* \quad (11b)$$

where

$$\begin{aligned} C_1 &= 2 \frac{A_p}{A_m} \left(K_p - \frac{A_p}{A_m} \beta \right) \\ C_2 &= -2 \left(\frac{A_p}{A_m} \right)^2 \beta \\ C_3 &= 2 \frac{A_p}{A_m} \left[\frac{1}{A^*} \left(1 - \frac{A_m}{2 A^* A_p} \right) \beta - \frac{A_p}{A_m} \beta \right] \end{aligned} \quad (11c)$$

Equation (11b) may be expressed as a simple functional relationship

$$\Delta P^* = F(W^*, T^*) . \quad (12)$$

C. EXPERIMENTAL CORRELATION

It is desirable to make a direct comparison of prototype and model performance on a one-to-one basis so that the effects of changes in geometric parameters on eductor

performance may be readily evaluated in terms of expected prototype performance. The ratio of absolute secondary to primary flow temperatures, T^* , was the only parameter which was not controlled during the experimental testing. Therefore, a means of presenting the experimental data for a given geometric configuration in a form which results in a pseudo-independence of the dimensionless groupings ΔP^* and W^* upon T^* must be developed. From equation (11b), a satisfactory correlation of ΔP^* , T^* and W^* for all temperatures and flow rates takes the form

$$\frac{\Delta P^*}{T^*} = \phi(W^* T^{*.44}) \quad (13)$$

where the exponent n is determined to be equal to 0.44 [2]. The experimental data is then correlated and analyzed using equation (13), that is $\Delta P^*/T^*$ is plotted as a function of $W^* T^{*.44}$ to yield an eductor's pumping characteristic curve. Variations in geometry will change the appearance of the pumping characteristic curve and facilitate a direct one-to-one comparison of pumping ability between model and full scale prototype eductor. For ease of discussion, $W^* T^{*.44}$ is hereafter referred to as the pumping coefficient.

III. EXPERIMENTAL APPARATUS

A. PRIMARY AIR SYSTEM

The primary air system is illustrated in Figure 4. Primary air is provided by a Spencer turbo-compressor, pictured in Figure 5, rated at 600 cfm at a delivery pressure of 6 psig. Control over the flow delivered to the eductor was provided by adjusting the gate valve (8) located between the compressor discharge and the butterfly blast gate (6).

Air intake to the compressor was through an arrangement of 10.8 cm (4.25 inch) diameter steel pipe and 10.2 cm (4.0 inch) diameter PVC (Polyvinyl-Chloride) pipe with a 40.64 cm (16.0 inch) elliptic inlet nozzle (2) attached. The PVC pipe was connected to a valve tree (4) that provided for bypass of the inlet ducting but was not used during this study. The compressor was equipped with two flow-noise suppression devices. The first was a fiberglass lined plywood box that hooded the inlet nozzle (1) and absorbed noise radiated from the nozzle. The second was a fiberglass lined plywood box (7) that was bolted to the compressor discharge just above the blast gate. The box was equipped with internal baffles which required the exhaust flow to follow a tortuous path and effectively absorbed most of the compressor exhaust flow noise without imposing a back-pressure penalty on the unit.

A short length of cloth and steel-spiral flexible hose (9) connected the compressor to the main primary ducting and allowed for an approximate 0.61 m (2 ft) difference in elevation of the two. The main primary flow ducting (10) was constructed of commercial grade ABS (Acrylonitrile-Butadiene-Styrene) 7.62 cm (3.0 inch) diameter pipe with a wall thickness of 0.81 mm (0.205 inch).

A standard ASME square-edged orifice (11) was situated 3.05 m (10 feet) downstream from the flexible hose connection. The orifice was held in place by two specially constructed plexiglass flanges which were epoxied to the pipe. Proper sealing of the orifice flanges was assured by the compression of two O-rings on either side of the orifice plate as the flanges were bolted together. The orifice plate was machined from 0.239 cm (0.094 inches) thick type 304 stainless steel with an orifice diameter of 5.471 cm (2.154 inches). The inside diameter of the ABS pipe at the flanges was 7.813 cm (3.076 inches) which yields an orifice beta ($\beta = \frac{d}{D}$) of 0.700. The orifice was equipped with standard one-diameter and one-half diameter pressure taps, which, along with the other orifice specifications, are in compliance with the ASME Power Test Code [4].

The eductor uptake and the various lengths of mixing stack were cut from 7.62 cm (3.0 inch) inside-diameter smooth copper pipe with a 0.173 cm (0.068 inch) wall thickness. The 1.524 m (5.0 ft) long uptake was connected to the ABS

pipe 89 cm (35 inches) downstream from the orifice plate. A specially constructed bakelite connector equipped with O ring seals joined the ABS pipe to the copper pipe in a sliding, air-tight fit. The uptake pipe extended through the rear seal of the secondary air plenum and, when fitted with a nozzle, became the primary air flow element of the eductor.

B. SECONDARY AIR PLENUM

The secondary air plenum pictured in Figure 6 was constructed from 1.905 cm (3/4 inch) plywood measuring 1.22 m X 0.92 m X 0.92 m (4 ft X 3 ft X 3 ft). It served as an enclosure that surrounded and supported the eductor under test and allowed the secondary or induced air flow through the eductor to be measured by means of multiple ASME long radius nozzles penetrating the plenum. Access to the eductor was provided by a hinged top to the plenum which seated on silicone rubber gaskets on the periphery of the opening. The hinges were designed so that the application of positive pressure to the top was necessary when closing the plenum in order to engage the hold-down bolts. This feature assured an air-tight seal when the bolts were tightened.

The plenum was equipped with flow-straightening screens across the mid-section which separated the front half containing the eductor from the rear containing the secondary flow nozzles, Figure 7. The screens provided for the

8 damping of any gross turbulence that could affect the eductor under test.

The plenum was supported by a triangular wooden frame fitted with three leveling bolts upon which the plenum rested. The plenum and frame were light enough to permit easy movement in order to align the uptake with the primary flow ducting.

Nine ASME long radius flow nozzles constructed in compliance with the specifications in the ASME Power Test Code [4] were fitted in the rear section and in the top of the plenum as shown in Figures 6 and 7. The particular arrangement of the nozzles provided for the minimum separation distance between nozzles as specified in [4] while assuring some degree of symmetry could be maintained with regard to the open nozzles when data was taken and the nozzles sequentially plugged. Three 5.08 cm (2.0 inch) throat-diameter, three 3.81 cm (1.5 inch) throat-diameter, and three 2.54 cm (1.0 inch) throat-diameter nozzles were used which allowed for secondary air flow areas ranging between 110.21 cm^2 (17.082 in^2), when all nozzles were open, and zero when all were plugged. The nozzles were plugged with rubber stoppers of appropriate size.

The penetration fittings for the uptake and mixing stack pictured in Figure 8 were specially constructed to provide support, sealing, and alignment. The fittings were machined from heavy bakelite and were equipped with two O-ring seals each, which provided an air-tight seal yet allowed the uptake

and mixing stack to slide in and out when changing eductor geometry.

C. INSTRUMENTATION

The performance of the eductor was calculated from pressure and temperature data taken at various points in the flow system. Compressor performance was monitored by a pressure tap and thermocouple mounted just below the blast gate in the compressor discharge. The back pressure on the compressor was critical in fixing the discharge air temperature. Throughout the study the compressor discharge pressure was maintained at six inches of mercury (2.95 psig) which kept the primary flow temperature to the eductor near 66 °C (150 °F).

The primary mass flow rate was calculated by measuring the pressure drop across the square edged orifice using the procedure detailed in the ASME Power Test Code [4]. A pressure drop of 10 inches of water (0.36 psig) across the orifice corresponded to an uptake Mach number of 0.068.

The primary flow velocity through the eductor nozzle was calculated using the uptake pressure measured just upstream of the nozzle plate. This pressure was in the 6 to 12 inches of water (0.22 to 0.43 psig) range at uptake Mach number of 0.068. Changes in eductor geometry and secondary air plenum pressure affected both orifice pressure drop and uptake pressure. This effect was compensated for as detailed in the description of experimental procedure below.

The secondary air mass flow rate was computed by using the pressure drop across the secondary air nozzles. The secondary air plenum was equipped with pressure taps mounted on four sides, both in the rear section containing the flow nozzles and in the front section containing the eductor under test. No measurable pressure drop was detected across the screens dividing the plenum so the pressure tap nearest the eductor was used in data runs.

The mixing stack pressure distribution was obtained by measuring the pressure at intervals along the mixing stack. A unique system of moveable pressure taps was devised to facilitate rapid changes in eductor geometry. The 2.36 mm (0.093 inch) pressure tap holes in the mixing stack tubes were each covered by a plexiglass saddle which contained the pressure tap fitting (see Figure 9). The saddles were installed with a thin layer of vacuum grease on their bearing surfaces to seal them to the mixing stack when fastened with a hose clamp. Installation was aided by a pin which assured proper alignment between the pressure saddles and the hole in the mixing stack. This arrangement facilitated mixing stack alignment and geometry changes by keeping the stacks free from external protuberances.

Two copper-constantan thermocouples were used to measure the compressor discharge and the primary air temperatures. The compressor thermocouple was mounted as described above. The primary air thermocouple was mounted 45.7 cm (18 inches) downstream from the orifice plate and was inserted through

the duct wall through a fitting epoxied to the duct. Both thermocouples were encased in stainless steel sheaths. The thermocouples were connected to a multi-channel Newport Digital Pyrometer which indicated the temperature in degrees Fahrenheit. The secondary air temperature was measured with a standard mercury in glass thermometer calibrated in degrees Fahrenheit.

Barometric pressure readings were taken from a standard mercury column barometer. The readings obtained were corrected for temperature and latitude (gravity correction) to yield true atmospheric pressure.

Mixing stack exit velocity distributions were obtained by measuring the diametric dynamic pressure distribution across the mixing stack using a screw driven pitot tube pictured in Figure 10. The pitot tube was held rigidly in an adjustable traversing mechanism which was aligned to drive the tube across a diameter before data was taken. The traversing mechanism allowed the measurement of radial position to within ± 0.02 inches. The pitot tube was connected to a 12 inch inclined manometer which read directly in inches of water.

A variety of manometers were used to measure the various pressures throughout the system. Available were five, four, three, two, and one-inch inclined manometers and a 10 inch vertical manometer, all filled with red oil of specific gravity 0.834 and reading directly in inches of water (see

Figure 11). A multi-tubed, 50-inch vertical manometer bank filled with water and mercury was also used.

D. CONFIGURATIONS

The eductor geometries studied were classified into single and four-nozzle groups. The single-nozzle geometry is illustrated in Figures 12 and 13. The four-nozzle geometry is illustrated in Figures 12 and 13.

For each nozzle group, the parametric effects on performance of mixing stack entrance shape, mixing stack length to diameter ratio (L/D), and nozzle standoff to diameter ratio (S/D) were investigated. Additionally, during phase one of the study for single-nozzle eductors, the effect of three primary flow rates was considered. Upon completion of phase one, analysis indicated that primary mass flow rate was not a strong factor in eductor performance as shown graphically in Figures 14, 15, and 16. A similar finding by Ellin [2] for four-nozzle eductors justified restricting phase two of this study for four-nozzle eductors to a single primary flow rate. The single-nozzle configurations tested are listed in Table I and the four-nozzle configurations in Table II.

The mixing stack entrance shape was varied by attaching a transition piece to the stack. Three entrance shapes were investigated; conical, elliptic, and straight (no transition).

The conical transition, manufactured from plexiglass, is illustrated in Figures 17 and 18.

The elliptic transition, also manufactured from plexi-glass, is illustrated in Figures 18 and 19, and 20. The elliptic transition is essentially an ASME long radius nozzle and conforms in general to the specifications for such a nozzle with a 7.62 cm (3.0 inch) throat.

The mixing stack length to diameter ratios tested are listed in Tables I and II. In each case the L/D was computed from the open face of the transition to the end of the mixing stack as shown in Figure 21. The mixing stack diameter of 7.62 cm (3.0 inches) was constant for all cases. The curious L/D's for configurations with the elliptic transition are due to the transition length not being a multiple of 1.5 (D/2).

For the straight entrance configuration, the transitions were removed. The mixing stack end thus exposed was machined square and sharp with no radius or bevel.

The nozzle standoff distance is the clearance between the nozzle tip and the end of the mixing stack with no transition or the transition face plane with transitions attached. Negative S/D's occur when the nozzle is inserted into the transition as shown in Figure 22. The diameter used in computing S/D is that of the mixing stack straight section, 7.62 cm (3.0 inches), regardless of the transition. The S/D's used for the straight entrance region and the conical transition are straight forward and comprehensible. However, the S/D's used for the single nozzle in conjunction with the elliptic transition require further explanation.

The $S/D = -0.84$ occurs when the nozzle tip is inserted 6.38 cm (2.51 inches) inside the transition. It is at this point, arrived at from geometrical considerations, that the nozzle tip comes closest to the transition throat without the area between the shoulder of the uptake and the transition inner surface (area 1) being smaller than the area between the nozzle tip and the transition inner surface (area 2). In fact, it is at this point that the two areas are exactly equal. If area 1 were to become smaller than area 2, the secondary flow induced by the eductor would be governed by area 1, negating S/D as measured from the nozzle tip as a true parameter describing the eductor geometry. Therefore, $S/D = -0.84$ is the effective inner limit to which the nozzle tip may be inserted into the elliptic transition.

The $S/D = -0.24$ is the location of the nozzle tip that yields an area between the tip and transition inner surface exactly one-half of the difference between the area at $S/D = 0.0$ and $S/D = -0.84$. In equation form

$$AREA_{S/D=-0.24} = \frac{(AREA_{S/D=0}) - (AREA_{S/D=-0.84})}{2}$$

These S/D 's are better parameters for performance correlation than S/D 's based on some less awkward fractions which would yield performance information that could not be easily generalized to an eductor equipped with a curved transition of different shape or size.

The choice of S/D 's equal to -0.25, 0.0, 0.25, and 0.5 for the four nozzle configuration when using the elliptic transition was made because of the very difficult task of computing the effective flow area between the nozzle tips and the transition from geometrical considerations. The results presented below for this configuration thus lack generality and are applicable only to an eductor equipped with an exact replica of the elliptic transition used in this study.

IV. EXPERIMENTAL PROCEDURE

Evaluation of eductor performance requires determination of the primary and secondary flow rates and some method of quantifying the degree of mixing of the primary and secondary flows. The primary and secondary flow rates describe the pumping characteristics of the eductor. The degree of mixing was determined by measuring the mixing stack exit plane velocity profile which was then integrated as described in Appendix A to determine K_m , the momentum correction factor. The velocity profile also yielded information for the alternate method of evaluating the degree of mixing which involves the ratio of maximum to average velocity.

A standard sequence for experimental data collection was developed and followed rigorously in order to assure repeatability of the data from one day to the next with different atmospheric conditions. The sequence of events for a sample data run is as follows.

1. Barometric pressure recorded and corrected for temperature and latitude to yield atmospheric pressure.
2. Turbo-Compressor started 10 to 15 minutes prior to data collection to allow exhaust temperature to stabilize.
3. With manometer switching manifold open to the atmosphere, zeroed all inclined manometers. Recorded atmospheric temperature.

4. With secondary air plenum open, recorded mixing stack pressure distribution at uptake Mach number of 0.068.
5. Recorded data for velocity profile. For the four nozzle configuration, two pitot-tube traverses were made as shown in Figure 40. The "A" traverse crossed the mixing stack exit so as to pass over the centers of two radially opposed nozzles. For the "B" traverse, the uptake was rotated so that the pitot-tube traverse crossed between the nozzles.
6. Recorded data ΔP_{or} , P_{or} , P_u , and T_u for the plenum open condition.
7. Closed the plenum, recorded ΔP_{or} , P_{or} , P_u , T_u , and P_s with all the secondary flow measurement nozzles open.
8. Closed the flow measurement nozzles in a sequential manner, recording ΔP_{or} , P_{or} , P_u , T_u , and P_s at each step. Maintained primary flow constant by maintaining ΔP_{or} constant.
9. Changed flow rate or geometry and repeated steps 4 through 8.

The data collected was then punched on computer cards and processed by the NPS IBM model 360 computer to yield the non-dimensional parameters previously described that characterized the eductor performance.

As noted above in step 5, two velocity traverses were made for the four-nozzle configurations; the assumption

being that the three-dimensional velocity profile for this configuration was repeating circumferentially every 45 degrees. The integration scheme assumed that the three-dimensional velocity profile could be approximated by passing a sine curve through the repeating pattern of maximum and minimum velocities determined from the "A" and "B" traverses. The integrated flow rates calculated by this method were in close agreement ($\pm 1\%$) with the flow rates calculated by combining the secondary and primary flows as measured independently.

During the course of a data set, the primary flow rate from the turbo-compressor tended to increase as the plenum flow nozzles were plugged. The differing plenum pressures were sensed upstream at the turbo-compressor discharge, causing more or less flow to pass out the bypass controlled by the butterfly valve. The primary flow rate measured through the ASME orifice was a function of the orifice pressure drop, orifice upstream pressure, and the fluid density which in turn was a function of the fluid temperature and pressure. Of these variables, only the pressure drop or the upstream pressure could be controlled, but not both. Experimentation revealed that by maintaining the pressure drop constant by adjusting the primary flow gate valve, effective one variable control over the primary flow rate could be achieved. The flow rate was maintained constant within $\pm 3\%$ by this method.

V. DISCUSSION OF EXPERIMENTAL RESULTS

The evaluation of eductor performance considers two things, the amount of secondary air flow induced at a given primary air flow rate, referred to here as pumping, and the degree of mixing of primary and secondary flows within the mixing stack. When an eductor is employed to cool the exhaust gas from a gas turbine engine, a high pumping rate is desirable since this results in a low average mixing stack exit temperature. The degree of mixing which occurs within the mixing stack determines how closely the local values approach this average. Therefore, an evaluation of the performance of an eductor in this application must consider both its pumping ability and the extent of mixing produced. The approach taken in this study is to analyze the effect of specific geometric parameters individually on both pumping and mixing. Then, from the results of these analyses, the effect of a specific geometric parameter on total eductor performance is evaluated. Results of the individual analyses are summarized in Tables III, IV, V and VI.

Values of the pumping coefficient at the open to the environment operating point which are obtained from plots of experimental data using the correlation

$$\frac{\Delta P^*}{T^*} = \phi(W^* T^{*.44})$$

3 provide the basis for the analysis of geometric variation effects on pumping. Tabulated values of the pumping coefficient for the single-nozzle configurations tested are included in Table III and the four-nozzle configurations are included in Table IV.

The degree of mixing was evaluated by the determination of the momentum correction factor K_m or by the ratio of maximum to average velocity at the mixing stack exit. The closer either of these two values is to unity, the better the mixing that has occurred. Momentum correction factors for the four-nozzle configurations are given in Table V. Values for V_{\max}/V_{avg} for the single and four-nozzle configurations are given in Table VI.

Values for K_m were not computed and detailed velocity profiles were not taken for the single-nozzle configurations. The behavior of the velocity profiles for single-nozzle configurations have been well documented by Pucci [1] and others.

The data taken for the mixing stack pressure distribution for the eductors tested was of benefit in the analysis of the performance for a particular geometry even though it was not a primary characteristic used to evaluate performance. The pressure distribution was often helpful in resolving ambiguities in the pumping and mixing performance data. The distributions presented were non-dimensionalized in a manner similar to the pumping coefficient by normalizing with the secondary density and primary flow head as

$$PMS^* = \frac{PMS}{\rho_s H_D}$$

where

$$H_D = \frac{U^2}{2 \frac{p}{\rho_c}}$$

and where PMS is the measured mixing stack gage pressure, positive if greater than atmospheric and negative if less than atmospheric. A steep initial gradient for the non-dimensionalized pressure distribution curve can be interpreted as a high potential for the mixing process. Completeness of mixing can be inferred by a curve gradient which approaches zero at the mixing stack exit. Similarly, a steep initial gradient and a large negative value for the initial segment of the curve implies a high potential for pumping.

In preparing the performance plots, $\Delta P^*/T^*$ versus $W^*T^{.44}$, a slight amount of data scatter is encountered as the educator's operating point is approached. This scatter is attributed to the difficulty in measuring the very small pressure differentials, on the order of 0.10 inches of water and less, required for calculation of these last few data points. Consequently, less importance was given these scattered points when curve fitting the characteristic curve to the experimental data points.

The uncertainties in the pumping coefficient ($\pm 2.8\%$) and the pressure coefficient (± 0.5) are calculated in

Appendix B. For some of the geometric parameter variations to be discussed, changes in the pumping coefficient are within its uncertainty bounds. Caution should be exercised when using these changes for purposes other than to indicate a trend. Sample curves with uncertainty bounds indicated for pumping coefficient, velocity profile, and pressure distribution are included as Figures 23, 24, and 25 respectively. An uncertainty analysis for the momentum correction factor was not attempted because of the approximations inherent in its development. It is recognized that the uncertainty in the momentum correction factor is likely to exceed its changes; such changes are used, therefore, as indications of trends only.

In the interest of completeness, all computer printouts for all the data taken during the study are included herein. The computer printouts preserve the raw data taken and provide all final calculated results as well as some intermediate quantities which characterize the eductor's performance envelope. In addition, computer-drawn graphs of pumping performance, mixing stack pressure distribution, and velocity profile data are included for the four-nozzle configurations. Caution should be exercised when using the computer-drawn plots and graphs since the data points lack precise positioning. These plots and graphs are included as useful visualizations of performance trends only. The tabulated data, however, is accurate to at least three

significant digits and should be used for numerical work with this experimental data.

Tables of experimental data and figures illustrating eductor performance are grouped under single-nozzle and four-nozzle configurations. Within each nozzle grouping, the tables are further grouped by primary flow rate, mixing stack entrance shape, L/D , and then S/D .

Figures 14, 15, 16 and 26 pertain to the single-nozzle configurations. Figures 27 and 31 through 39 likewise pertain to the four-nozzle configurations. Computer printouts for the single-nozzle configurations are included as Tables VII through XIII. The printouts for the four-nozzle configurations are included in Tables XIV through XXIV.

The following discussion addresses the individual parametric variations and their effects on eductor performance and, in so doing, references results of tests on both single and four-nozzle configurations.

A. UPTAKE MACH NUMBER

Data for the single-nozzle configuration shows that the pumping coefficient is essentially independent of uptake Mach number. This behavior is shown in Figures 14, 15, and 16 for different L/D 's. This result is in agreement with the findings of Ellin [2] and Moss [3]. Based on these results, the primary flow rate was held constant for all geometries for the four-nozzle configurations.

B. SINGLE-NOZZLE CONFIGURATION

The data for the pumping characteristic for the single-nozzle configuration shown in Figure 26 indicates an interdependence of L/D , S/D , and mixing stack entrance shape, hereafter referred to as the transition, as they affect pumping. It is difficult to draw conclusions regarding any single parameter; except that, in general, increasing L/D tends to increase pumping until L/D becomes greater than 10.

With a straight transition, S/D is seen to have a large effect on pumping at short L/D 's. At an L/D of approximately 2.8, however, the performance curves tend to merge and become less dependent on S/D . The eductor equipped with an elliptic transition shows much better performance than the straight entrance, but only after S/D becomes greater than -0.84. This behavior is due to the high percentage of the secondary flow area which is blocked at $S/D = -0.84$. As S/D is increased greater than -0.25, its effect on pumping is less drastic.

The curves of Figure 26 indicate that the pumping coefficient reaches a maximum value in the interval $6 < L/D < 10$ and then slowly falls off as L/D is increased beyond 10. The L/D corresponding to the maximum can be determined by scrutiny of the mixing stack pressure distributions in this region. The maximum performance should occur at an L/D just short of that at which the mixing stack pressure rises above atmospheric. This is indicated by the non-dimensional mixing

stack pressure exceeding zero. The uncertainty associated with the measurements of the very small pressure differences that determine the pressure distribution in a given mixing stack make this determination from the experimental data problematical at best. However, the data indicate mixing stack pressures greater than atmospheric at an L/D of 7.57 for an S/D = 0, which means the optimum L/D is somewhat less than this. Data for mixing stack pressure distributions for the single-nozzle configurations are given in Tables VII through XIII.

Of special note is the region around L/D = 3 shown in Figure 26. In this region, the performance without a transition piece seems to be approaching the performance with such a transition piece. Also of note is that the performance at this L/D is approximately 84% of the maximum achieved at much greater L/D's. These two facts are significant when applied to eductor design for exhaust gas cooling applications due to the weight limitations. Unfortunately, no data was taken which overlaps this area so the curve behavior is approximate as indicated by the dashed lines.

The degree of mixing for the single-nozzle eductor is shown graphically in Figure 28. The values for V_{\max}/V_{avg} were calculated only at a single S/D due to the time limitations of this study. The curves show a general increase in the degree of mixing as L/D is increased. The elliptic transition gives better mixing than does the straight

entrance shape at the same L/D . This effect is most probably due to blockage of the secondary air flow path into the mixing stack at small S/D 's for the single nozzle.

C. FOUR-NOZZLE CONFIGURATION

Figure 27 graphically shows the pumping performance for the various four-nozzle configurations. As with the single nozzle, a strong interdependence of L/D , S/D , and transition shape is evident. The effects of small S/D 's are most pronounced for small values of L/D and affect the straight transition eductor more than those equipped with a conical or elliptic transition. The shapes of the curves are similar to those of the single-nozzle configurations although shifted upward indicating better performance. A direct comparison of the single-nozzle and four-nozzle configurations for similar S/D 's is made in Figure 30.

The general effect of increasing L/D is to increase pumping performance. The mixing stack pressure distributions for the four-nozzle eductor can indicate the optimum value of L/D as was discussed above for the single nozzle. Two mixing stack pressure distributions are given for each eductor configuration in the four-nozzle group in Tables XIV through XXIV. The "A" distribution is the pipe wall static pressure distribution taken when two radially opposed nozzles are in line with the wall pressure taps. The "B" distribution is taken 45 degrees away from the "A" distribution when the wall pressure taps are on a diameter which passes between

adjacent nozzles. These distributions correspond to the "A" and "B" velocity traverse directions indicated in Figure 40. The pressure distribution data indicate slight over-expansion at an L/D of 5.57 which means that the optimal L/D for a four-nozzle configuration equipped with an elliptic transition is somewhat less than that for a single nozzle eductor with similar entrance shape and S/D.

Of special significance is the region near $L/D = 3$. As with the single nozzle, the curves merge in this area and show a decreasing dependence on S/D and mixing stack transition shape. The four-nozzle eductor with a straight transition and $L/D = 3$ has an operating point pumping performance that is 92% of the maximum performance for four-nozzle eductors with greater L/D's. A four-nozzle eductor with straight transition at an $S/D = 0.5$ and at $L/D = 3$ achieves 96% of the performance of an eductor with an elliptic transition at the same L/D. This indicates a large potential savings in the weight and manufacturing complexity for eductors used to cool gas turbine engine exhausts.

Of note also is the lack of any substantive improvement in performance between an eductor with a conical entrance transition and one with the more complex elliptic shape. The improvement in performance gained by the addition of an elliptic or conical transition to the mixing stack entrance, though real, is probably not worth the added

cost, weight, and complexity that such an addition would add to a prototype design.

The mixing performance curves for the four-nozzle configurations are shown in Figure 29 for K_m and in Figure 28 for V_{\max}/V_{avg} . Both curves show an increased degree of mixing as L/D is increased. The better mixing for the straight transition at L/D 's greater than 2.5 can best be explained by recalling that both K_m and V_{\max}/V_{avg} are manifestations of momentum transfer between the high velocity primary air jet and the lower velocity induced secondary air. The driving potential for momentum exchange is the difference in velocity of the two flows. The addition of the conical or elliptic transition aids the acceleration of the secondary air into the mixing stack. As the two streams enter the constant area mixing stack, the secondary air is traveling at a higher velocity than if the transition were not present. This behavior can also be deduced from a comparison of the pumping characteristics of an eductor with straight transition and with an elliptic transition. The elliptic transition produces more pumping, which means an increased secondary air flow for a given primary air flow. Continuity requires that for greater volumes of air to pass through a duct of constant size, the velocity must increase.

At $L/D = 3$ the indications are that a straight-entrance mixing stack delivers better mixing than an elliptic or conical transition and only slightly worse pumping.

Moss [3] found that the curves for K_m for the straight and conical transitions crossed between $L/D = 2$ and $L/D = 3$. The data from this study indicate a similar trend but insufficient data were taken in this vicinity to draw firm conclusions.

D. COMPARISON OF SINGLE-NOZZLE AND FOUR-NOZZLE CONFIGURATIONS

Figure 30 shows a graphical comparison of the pumping performance for a single-nozzle and a four-nozzle eductor of otherwise similar geometry. The four-nozzle performance surpasses the single-nozzle at every L/D . This is most probably due to the increased area for momentum transfer for the four-nozzle configuration. If the sum of the primary nozzle circumferences is taken as a measure of the effective area for momentum transfer, the four-nozzle configuration is seen to have twice as much effective area as does the single-nozzle configuration.

VI. CONCLUSIONS

The intent of this study was to obtain data relating to a broad range of geometric variables as they affected the performance of single-nozzle and four-nozzle eductors. The interdependency of geometric variables was discussed in detail in Section V; the resulting conclusions are summarized here.

- A. The effect of uptake Mach number on the non-dimensionalized performance is small and can be discounted for Mach numbers well below the range where compressibility effects come into play.
- B. Four-nozzle eductors achieve better pumping and better mixing performance than do single-nozzle eductors of otherwise identical geometry, for L/D 's less than about eight.
- C. In general, increasing L/D increases pumping and mixing until L/D becomes so great that the mixing stack pressure must rise above atmospheric in order for the flow to continue. At this point frictional losses begin to have an increased effect on the flow and the pumping performance declines.
- D. For both the four-nozzle and the single-nozzle configurations, S/D is the dominant variable affecting the pumping performance for L/D 's less than 4.
- E. At short L/D 's, the addition of a conical or elliptic transition increases pumping but decreases mixing. For

3
this reason, the advantages of the addition of such a transition to shipboard eductors would not seem to outweigh the disadvantages of added cost, weight, and complexity.

- F. At L/D 's greater than 4, the addition of a conical or elliptic transition indicates an improved performance over the straight entrance. However, eductors equipped with conical and elliptic transitions did not show substantial differences in performance.
- G. By properly choosing S/D , an eductor with a straight entrance can achieve pumping equivalent to that of an eductor with a conical or elliptic transition at L/D 's near 3. The same straight entrance configuration exhibits greater mixing than does the conical or elliptic transition configuration which, when all factors are considered, indicates that the straight entrance configuration is a better choice for the design of gas turbine exhaust gas eductors with L/D 's near 3.

VII. RECOMMENDATIONS

In addition to the insight this study has given into the relationship between eductor geometry and performance, it has generated an awareness of a few shortcomings. Presented here are recommendations concerning areas requiring further study and certain improvements in apparatus which would make further study easier.

- A. More data are needed for the region of L/D between 2 and 4. It is this region which seems to offer the best promise for maximizing performance without incurring large weight and complexity penalties.
- B. The method of evaluating the thermal behavior of an eductor mixing stack by examination of the momentum transfer is approximate. Hot flow model tests are needed to confirm the validity of the approximation.
- C. The three-inch uptake and mixing stack sizes, though convenient for rapid geometry changes, presented problems in achieving precise alignment. The use of larger size uptakes and mixing stacks would obviate the necessity for the time consuming and tedious alignment of the uptake with the mixing stack.
- D. The uncertainties involved in the calculation of the open-to-the-environment operating point of the eductor and in the determination of the mixing stack pressure

distribution could be substantially reduced by the use of more sophisticated pressure measurement methods than were available for this study.

VIII. FIGURES

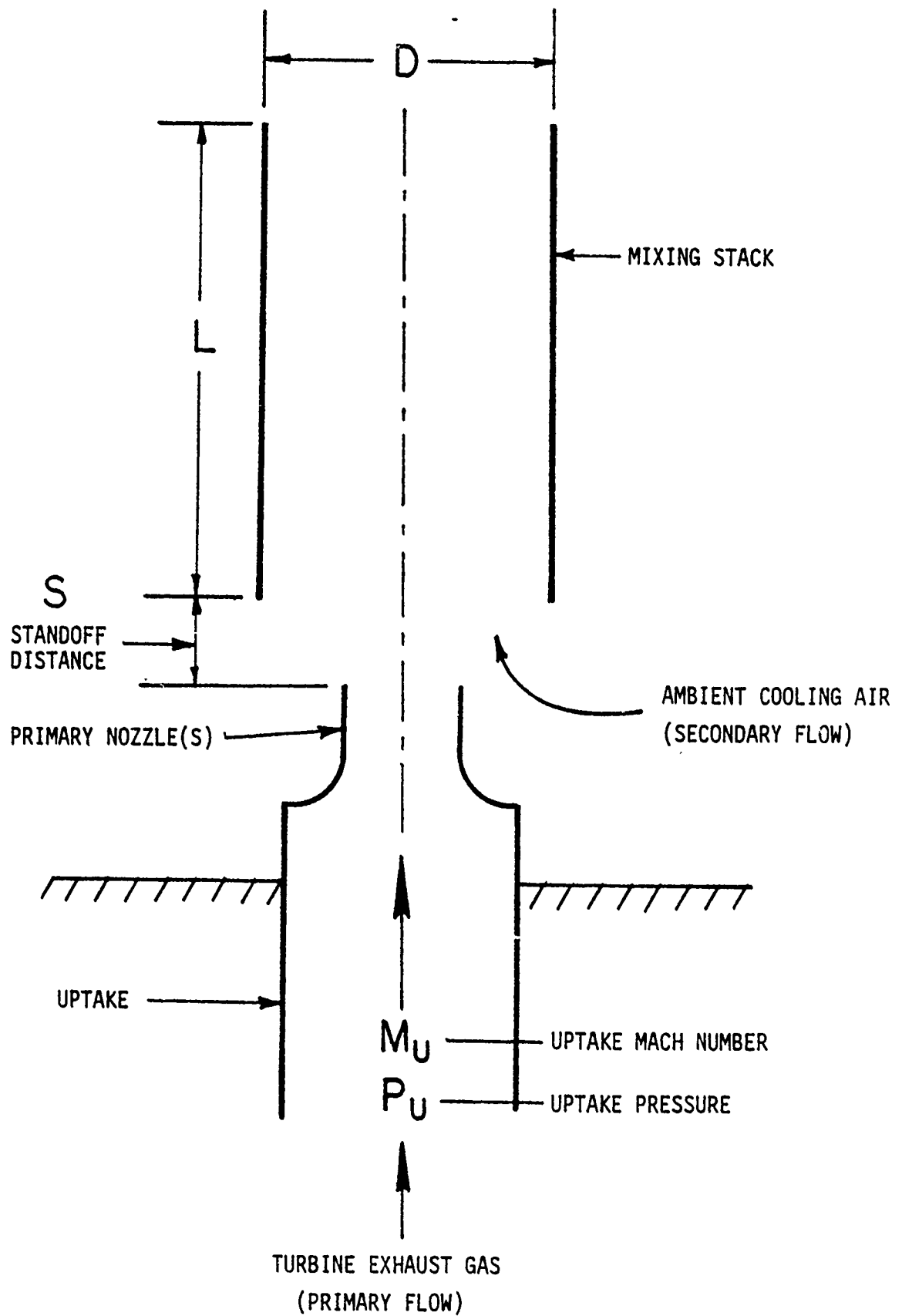


FIGURE 1. Schematic Diagram of Simple Exhaust Gas Eductor

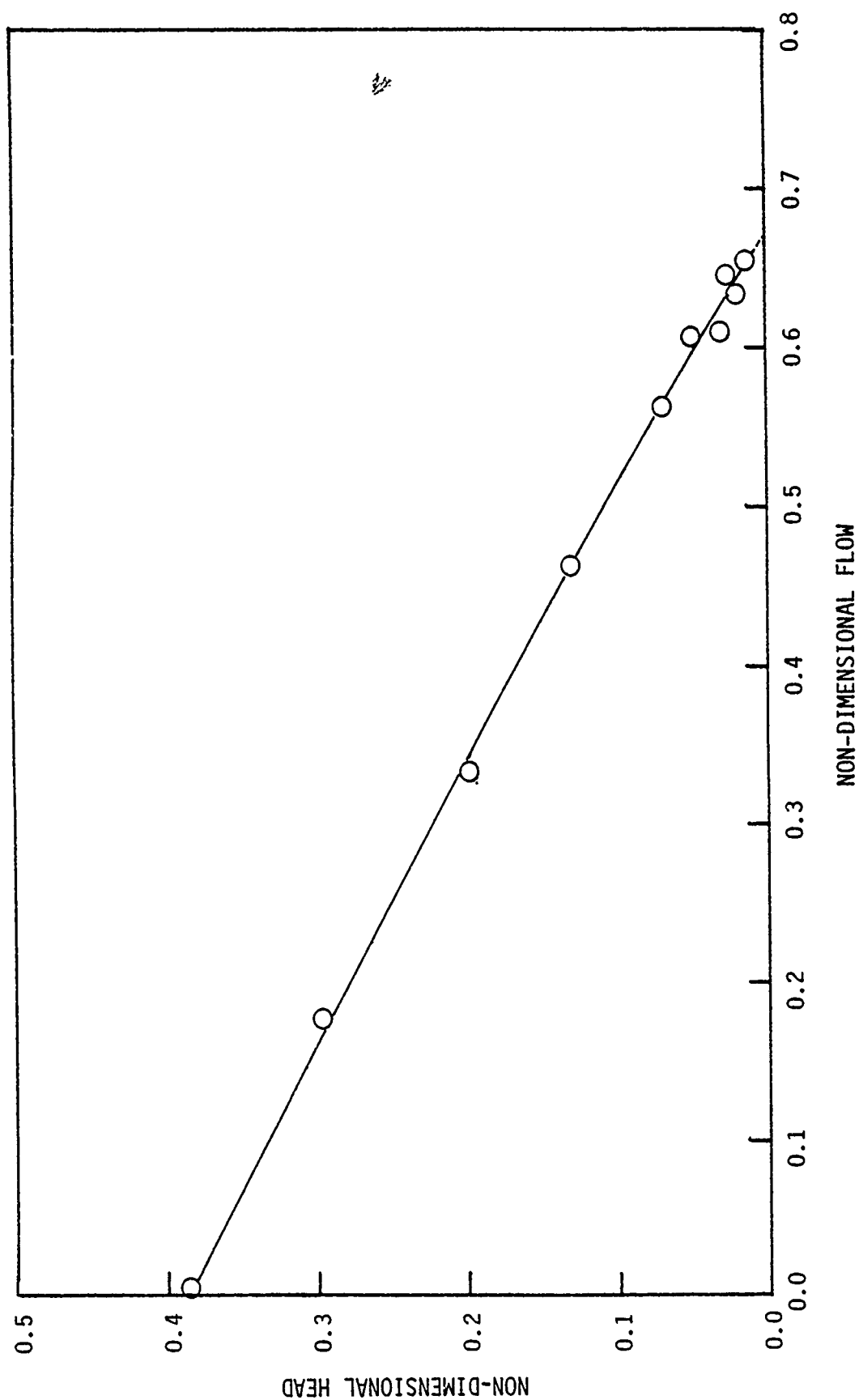


FIGURE 2. Sample Non-Dimensional Pumping Coefficient Curve.

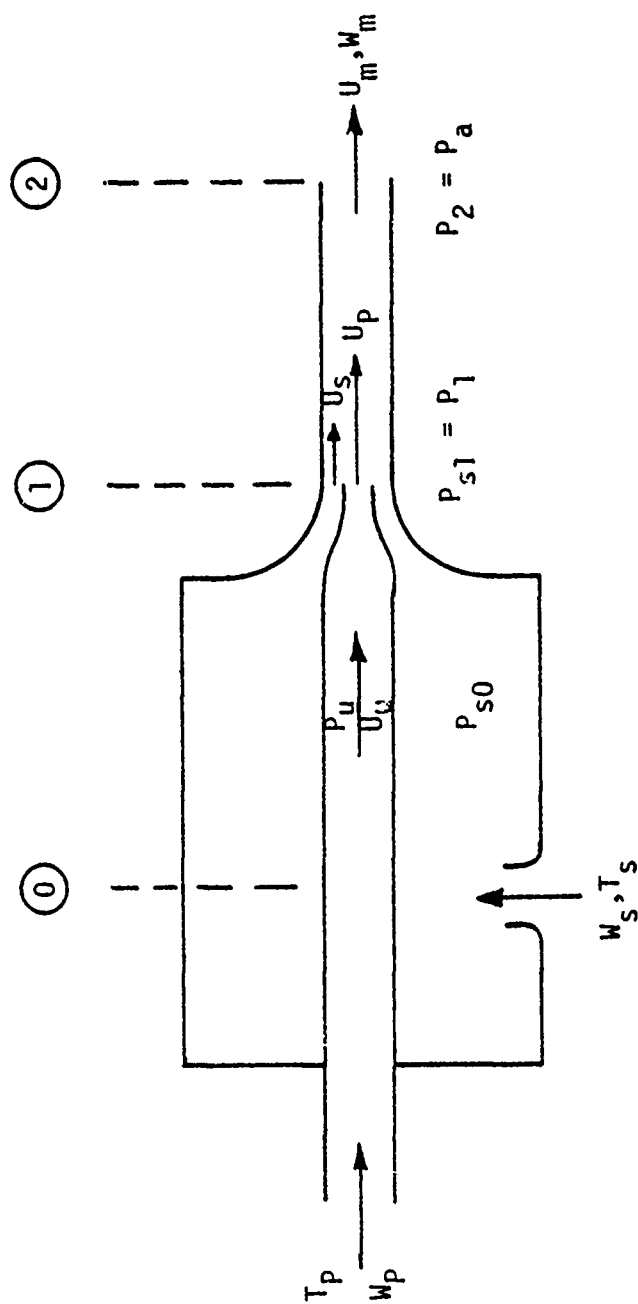


FIGURE 3. Simple Single-Nozzle Eductor System.

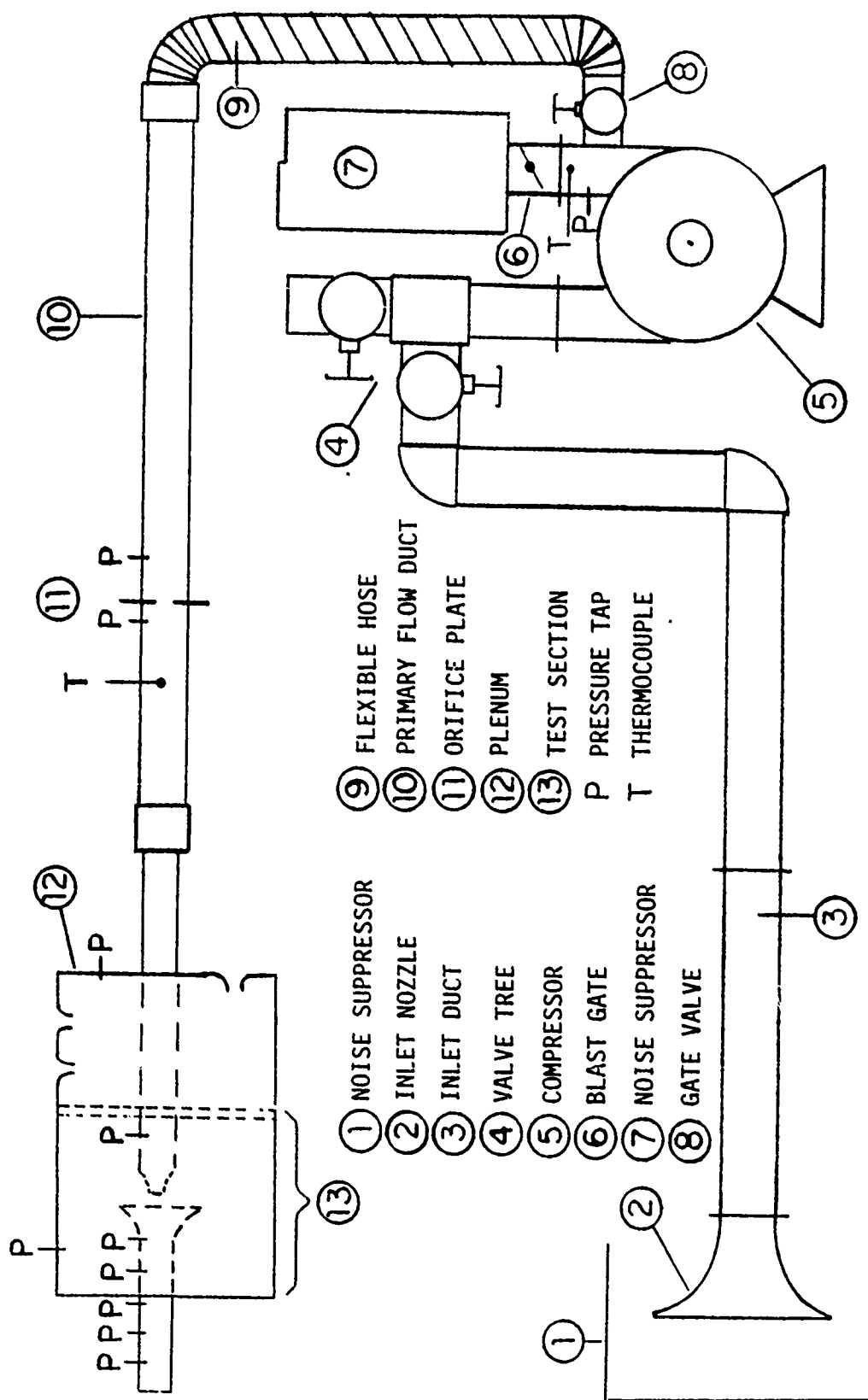


FIGURE 4. Test Rig Schematic Diagram.

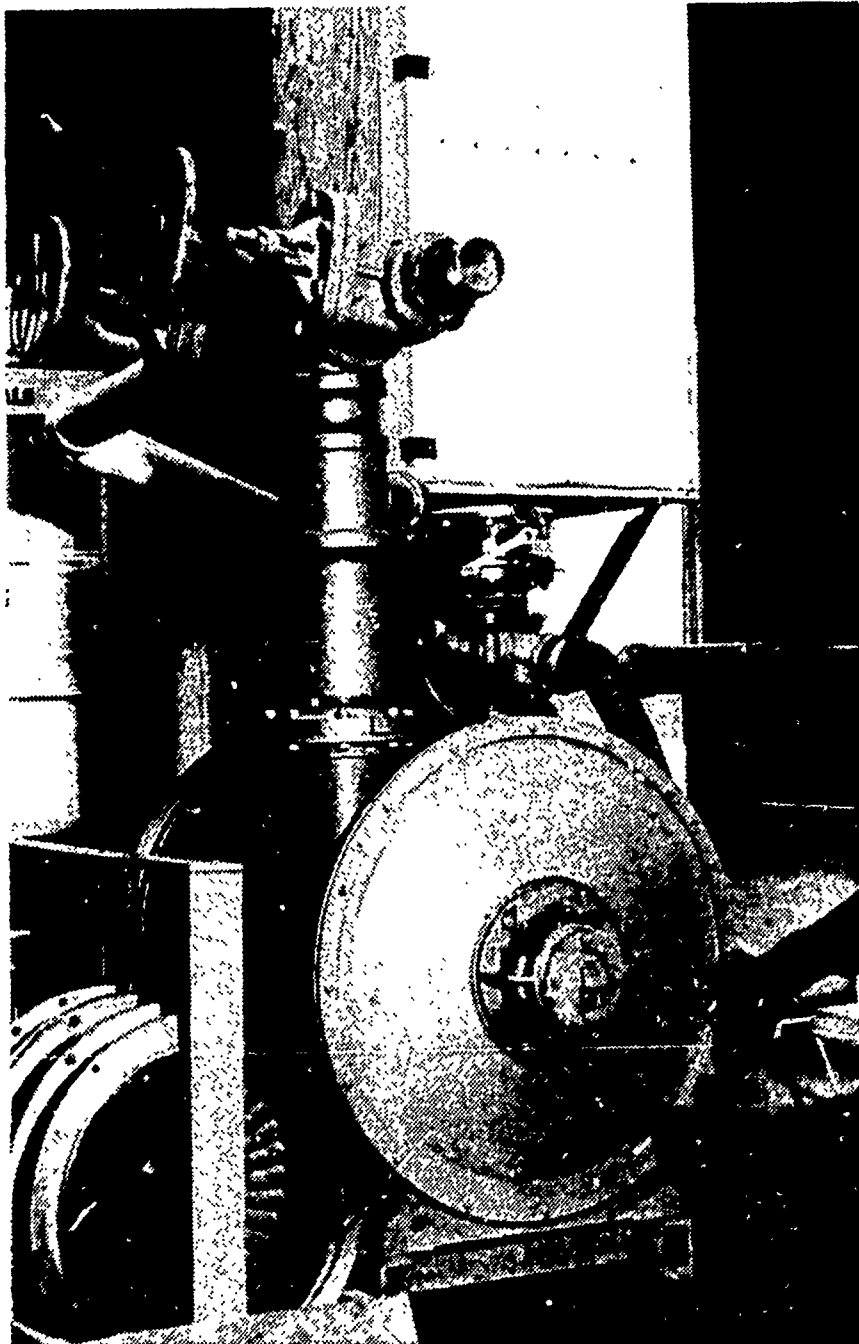


FIGURE 5. Primary Air Supply Turbo-Compressor.

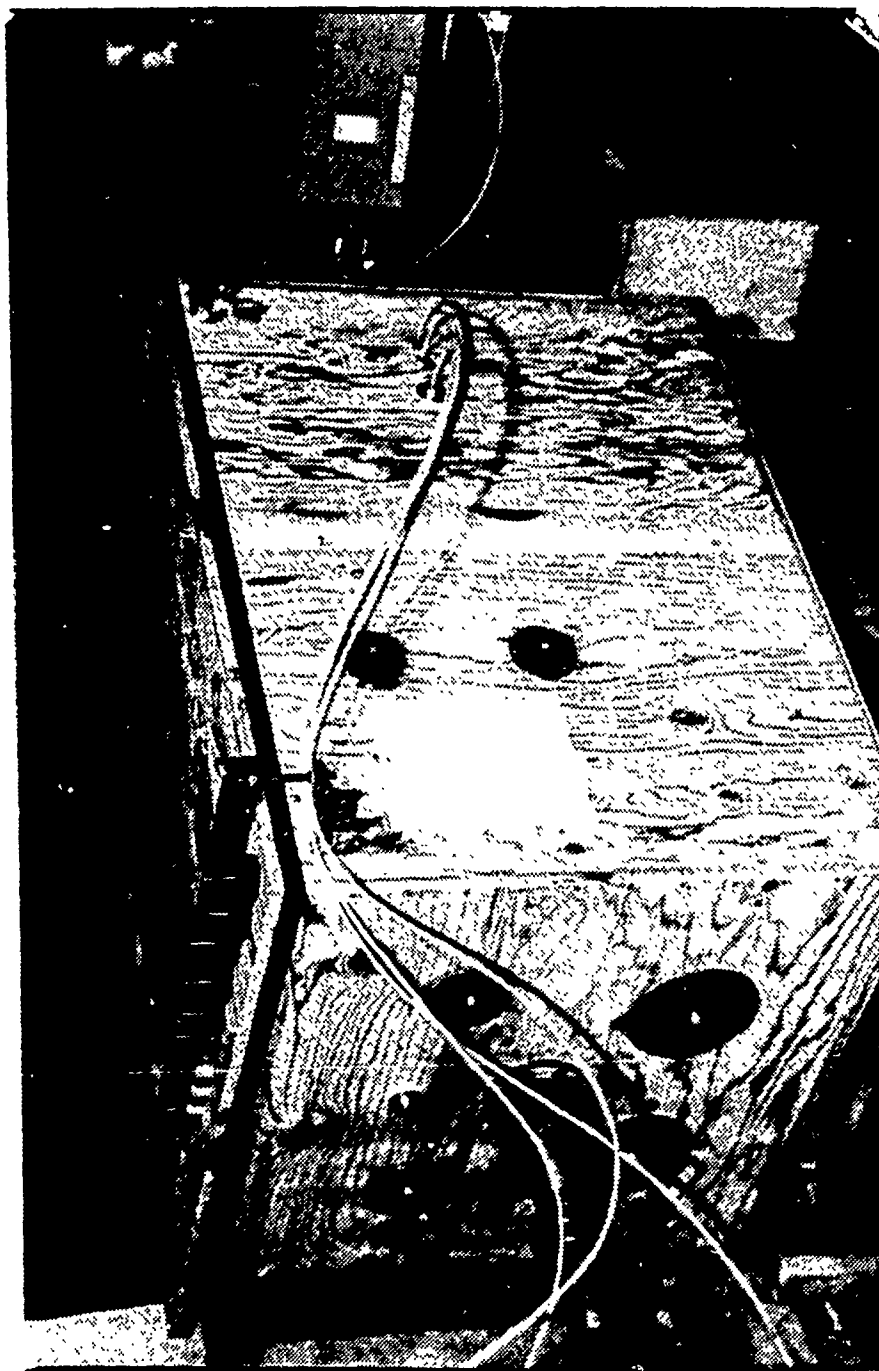


FIGURE 6. Secondary Air Plenum and Flow-Measuring Nozzles.

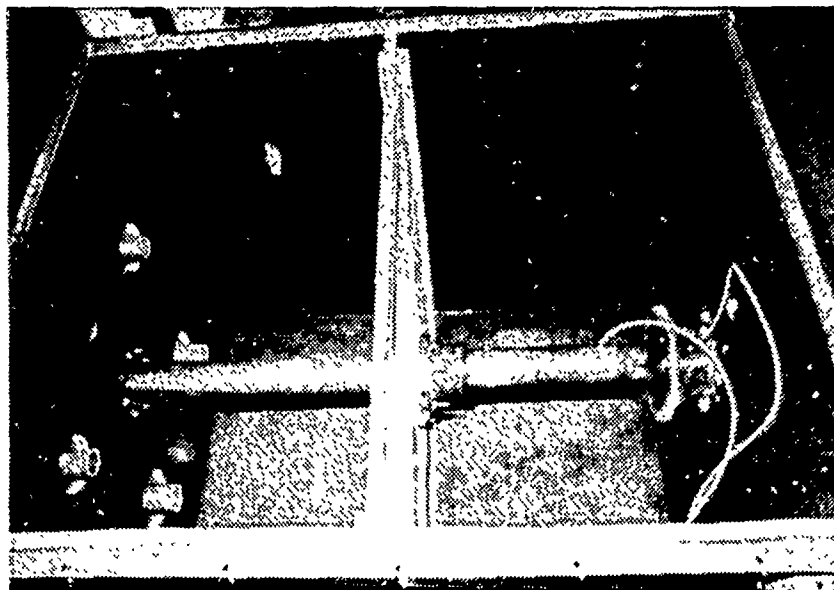


FIGURE 7. Secondary Air Plenum Interior.

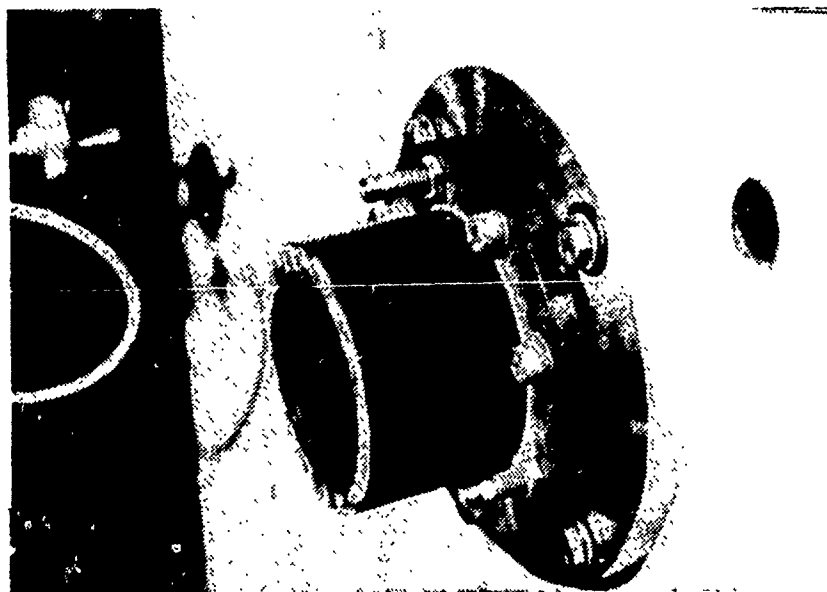


FIGURE 8. Plenum Penetration Fitting.

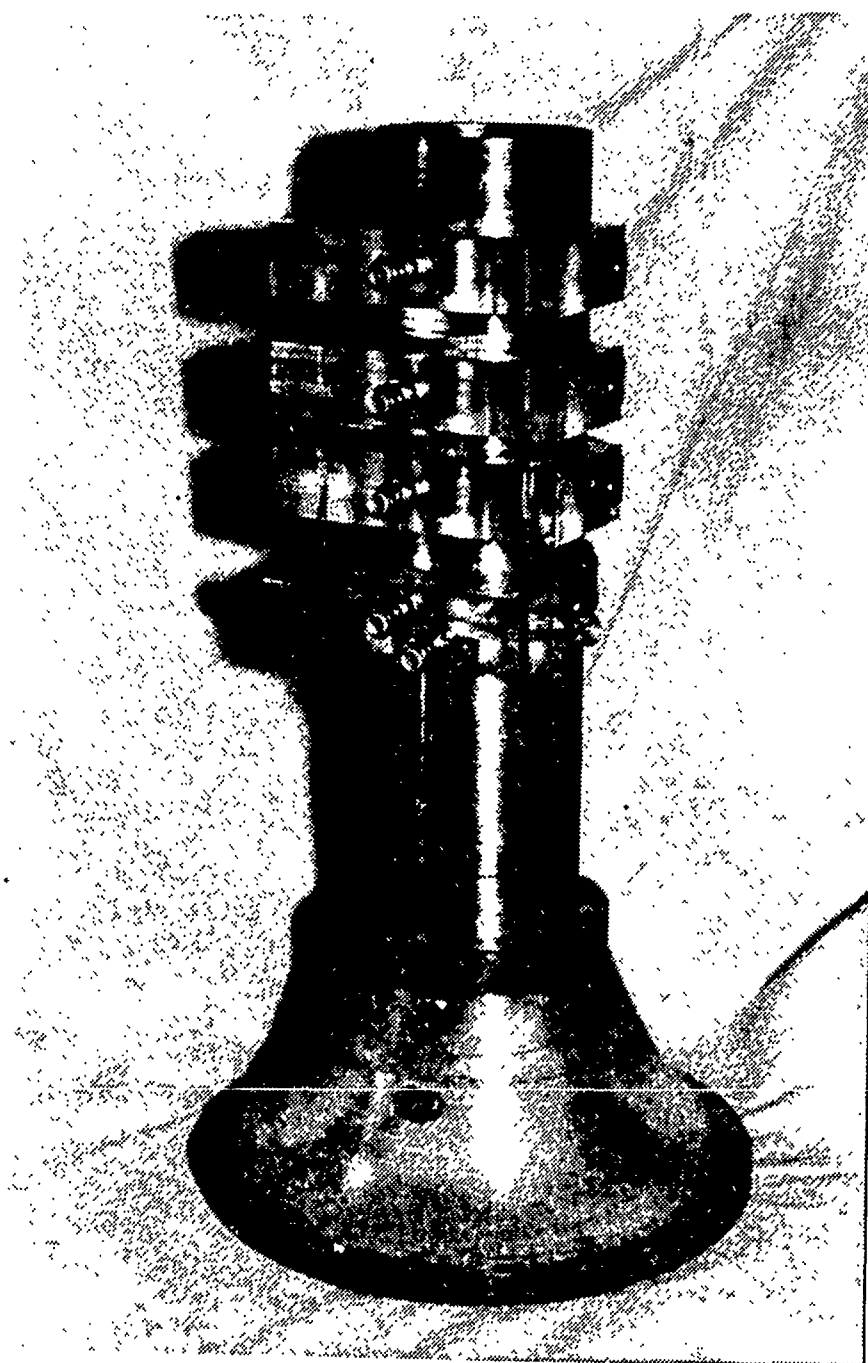


FIGURE 9. Mixing Stack with Elliptic Transition
and Plexiglass Pressure Saddles.

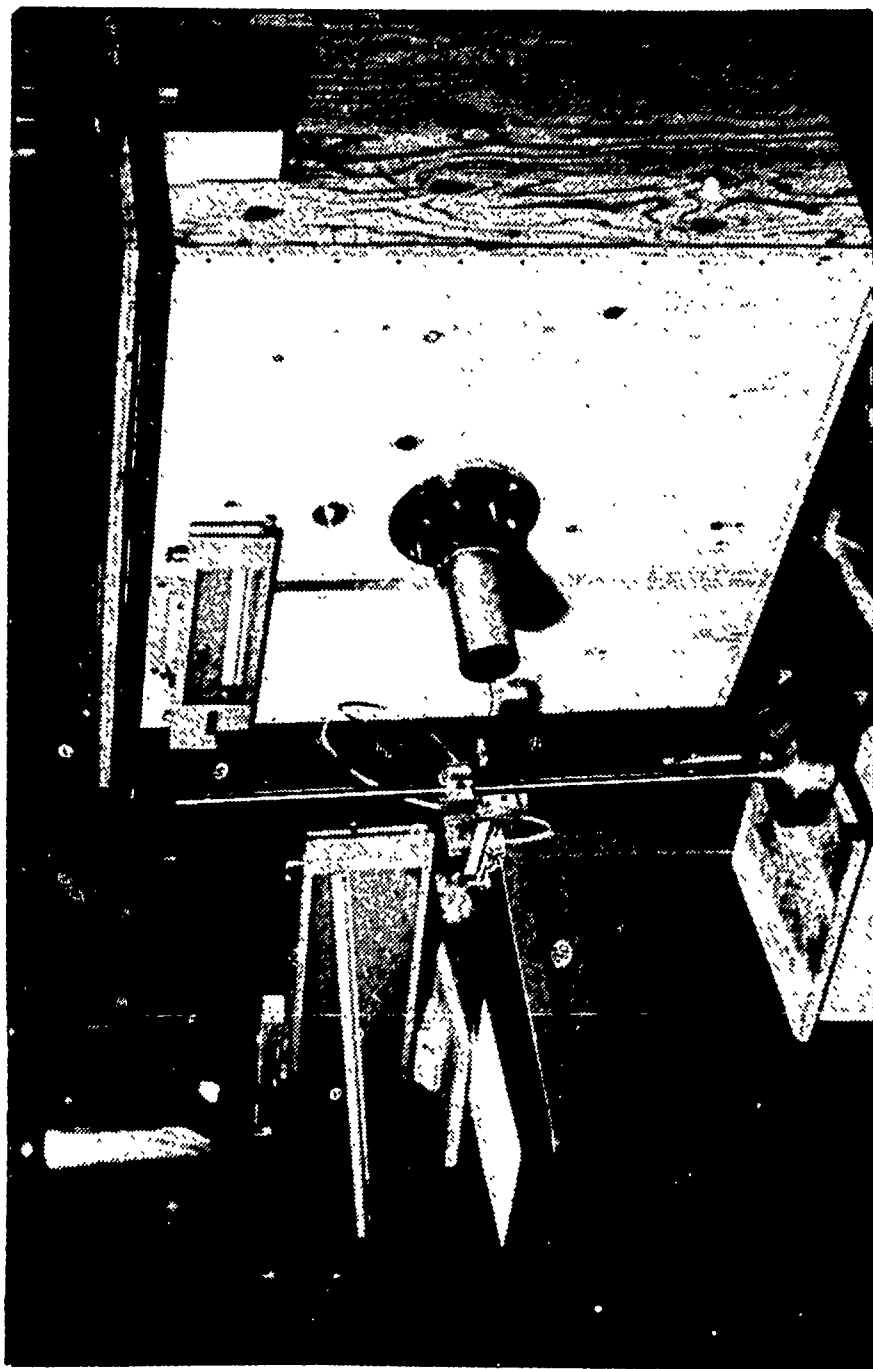


FIGURE 10. Mixing Stack Exit and Pitot-Tube Traversing Mechanism.

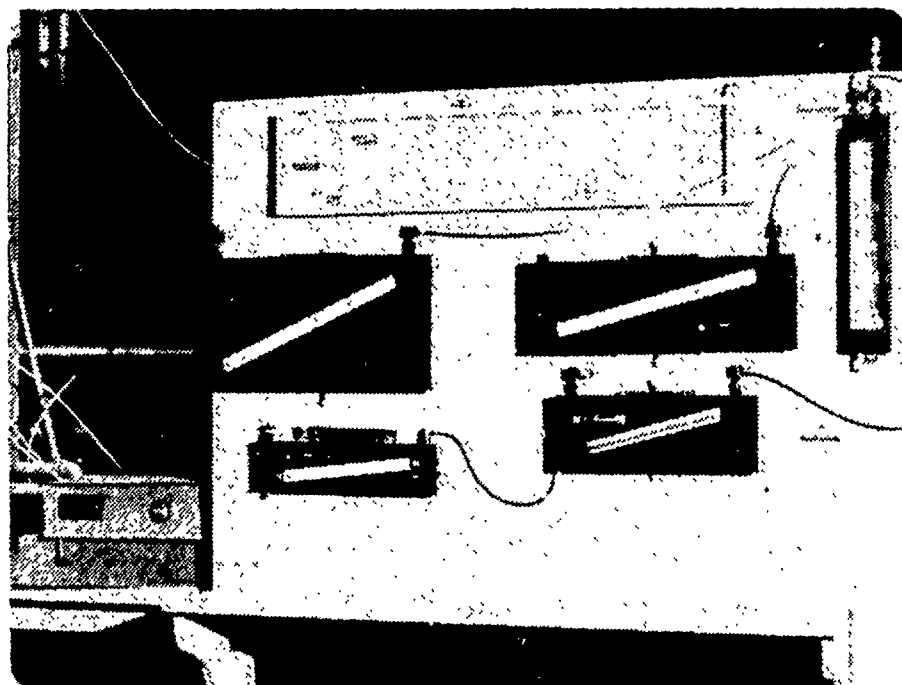


FIGURE 11. Digital Pyrometer and Main Manometer Board.

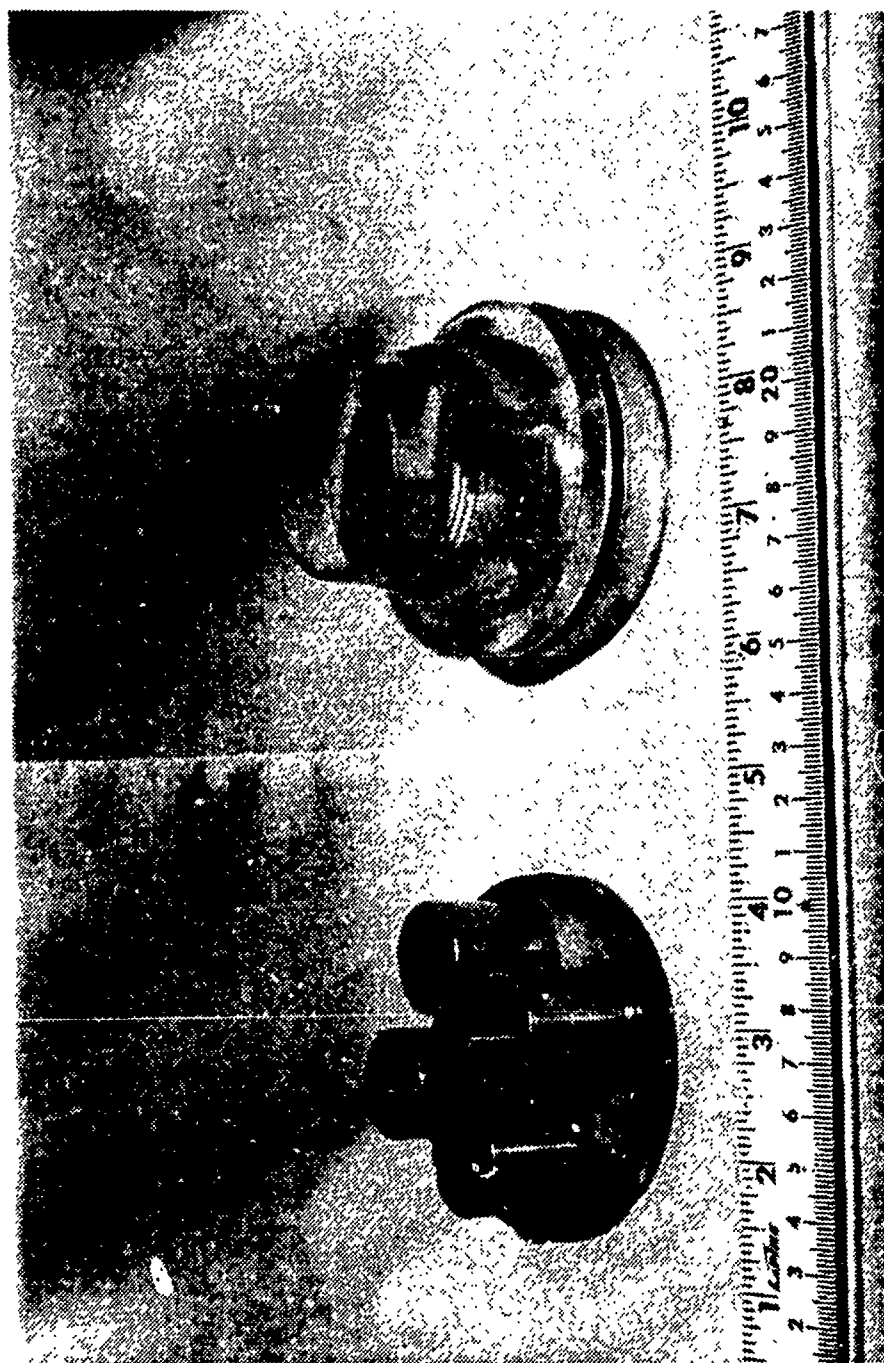
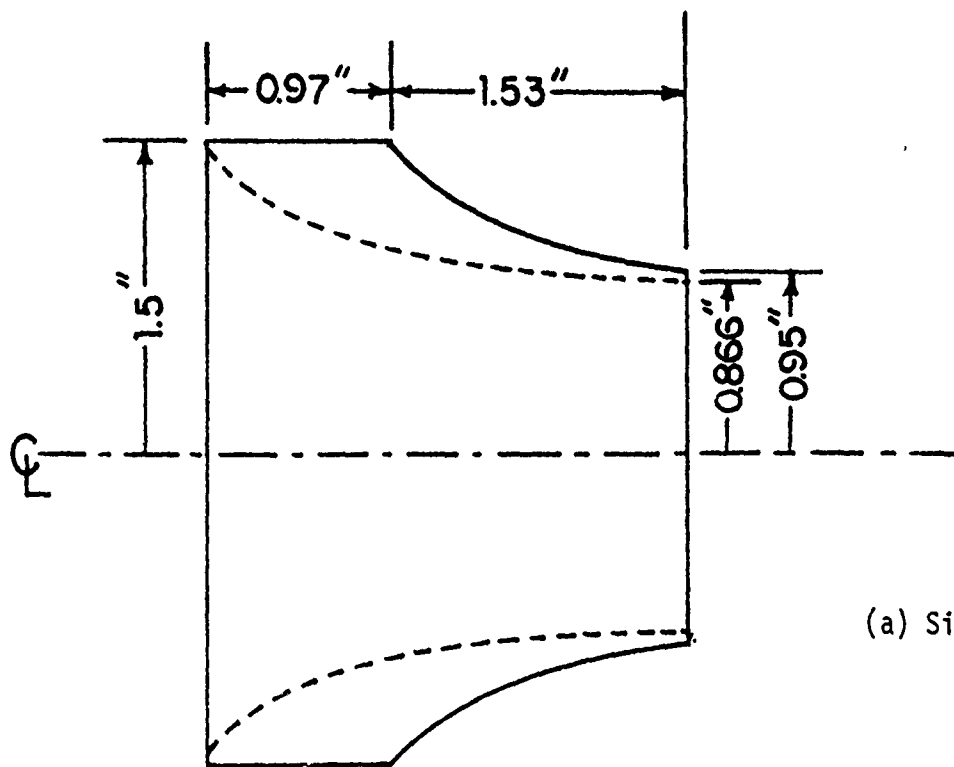
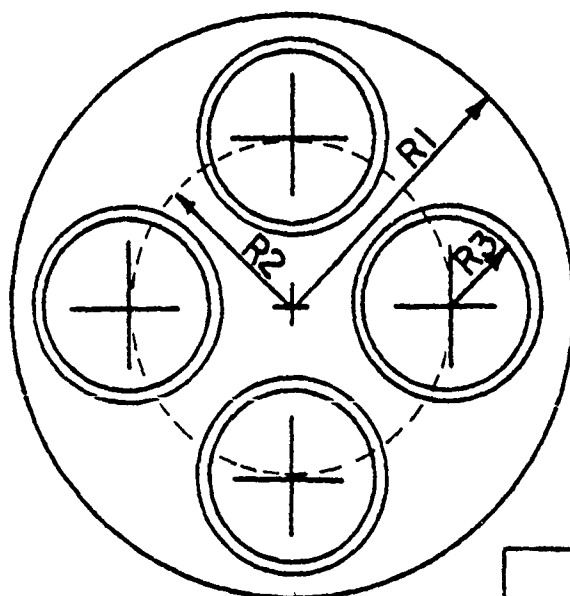


FIGURE 12. Four-Nozzle Plate and Single-Nozzle Primary Flow Nozzles.



(a) Single-Nozzle



(b) Four-Nozzle

R1 1.5 "
 R2 0.85 "
 R3 0.433 "
 A 0.5 "
 B 1.367 "
 T 0.041 "

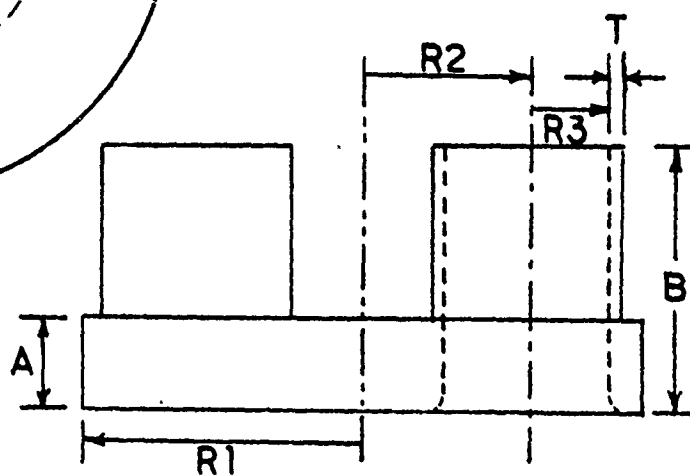


FIGURE 13. Single and Four-Nozzle Geometries.

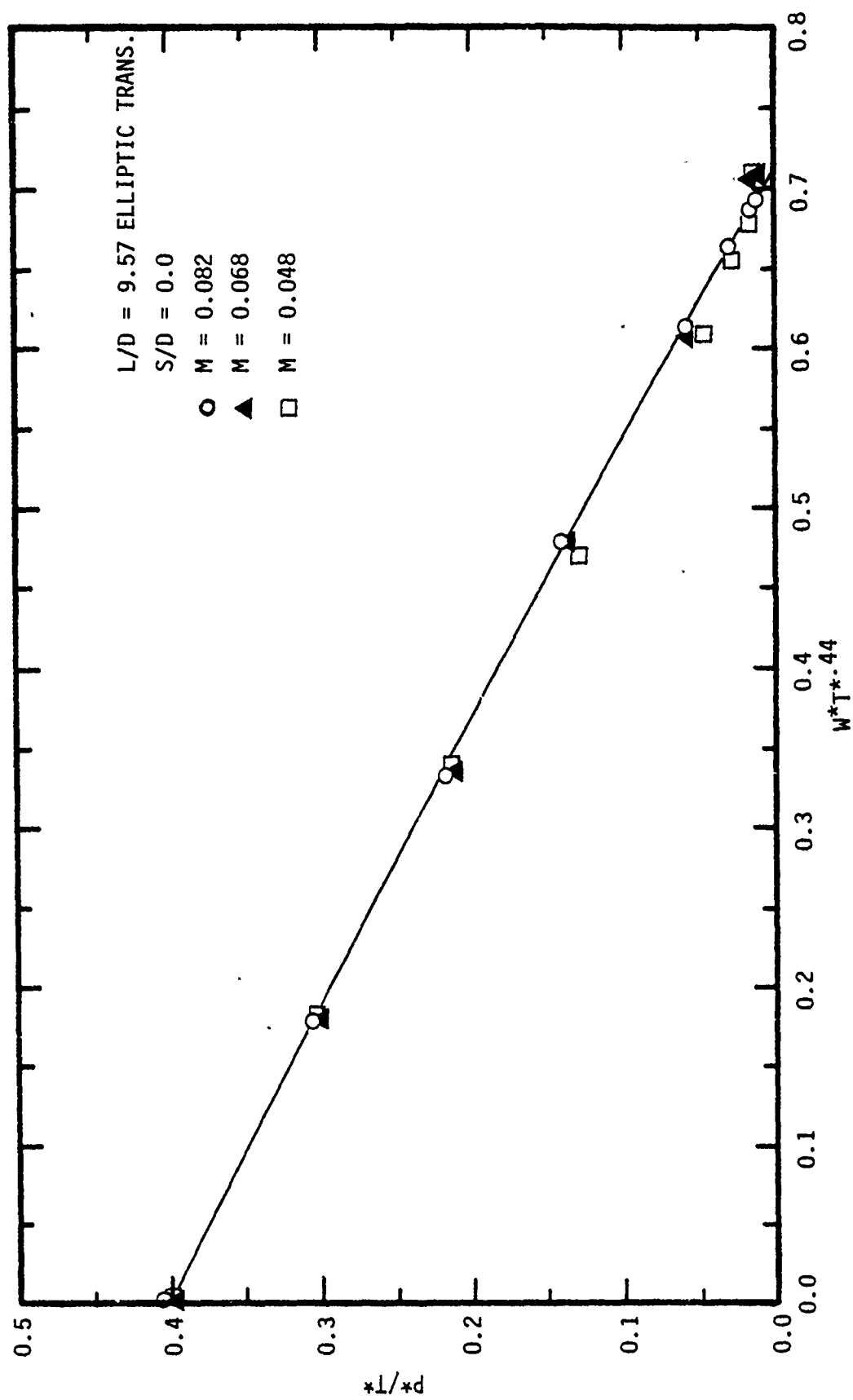


FIGURE 14. Single-Nozzle Pumping Characteristic for $L/D = 9.57$.

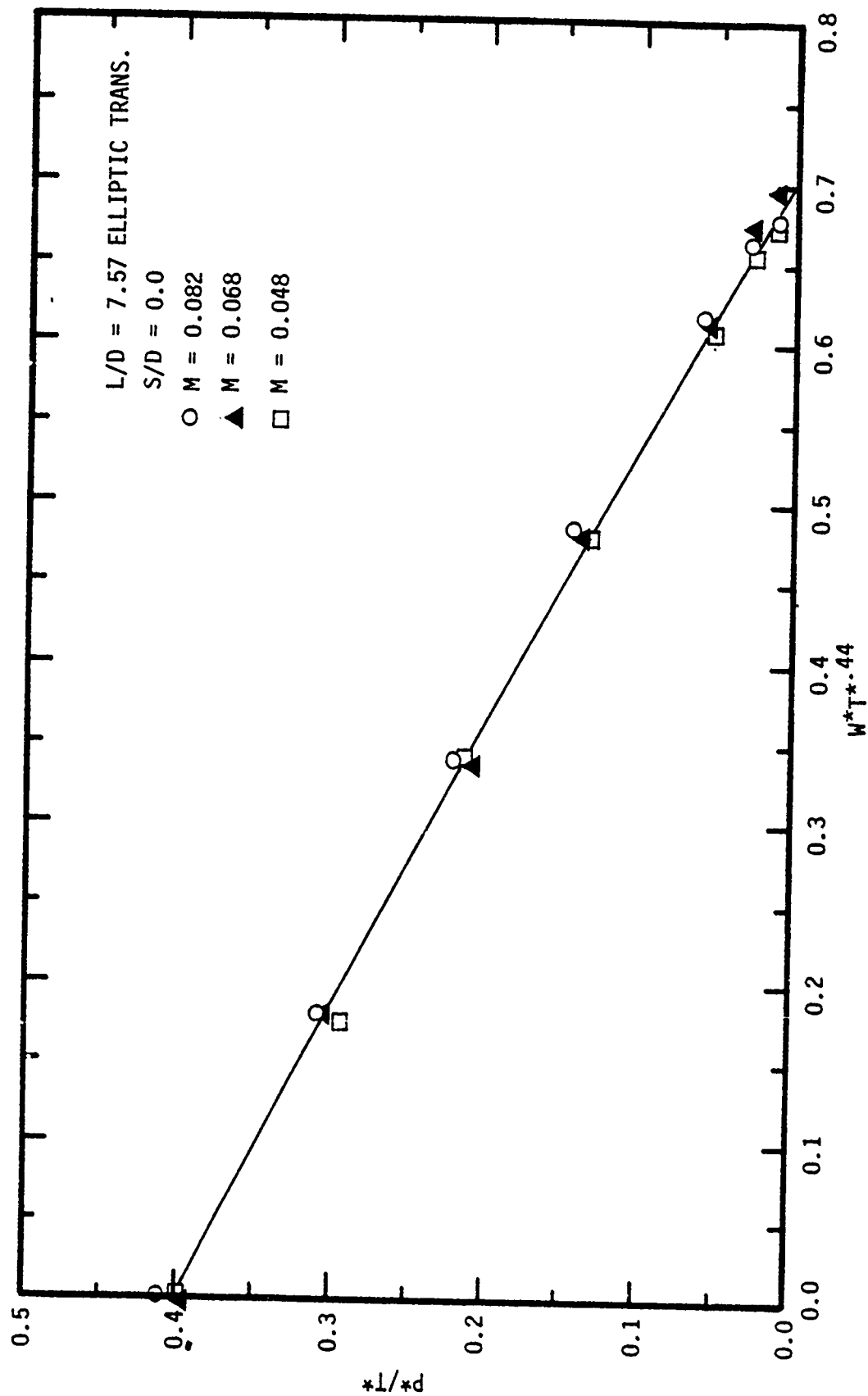


FIGURE 15. Single-Nozzle Pumping Characteristic for $L/D = 7.57$.

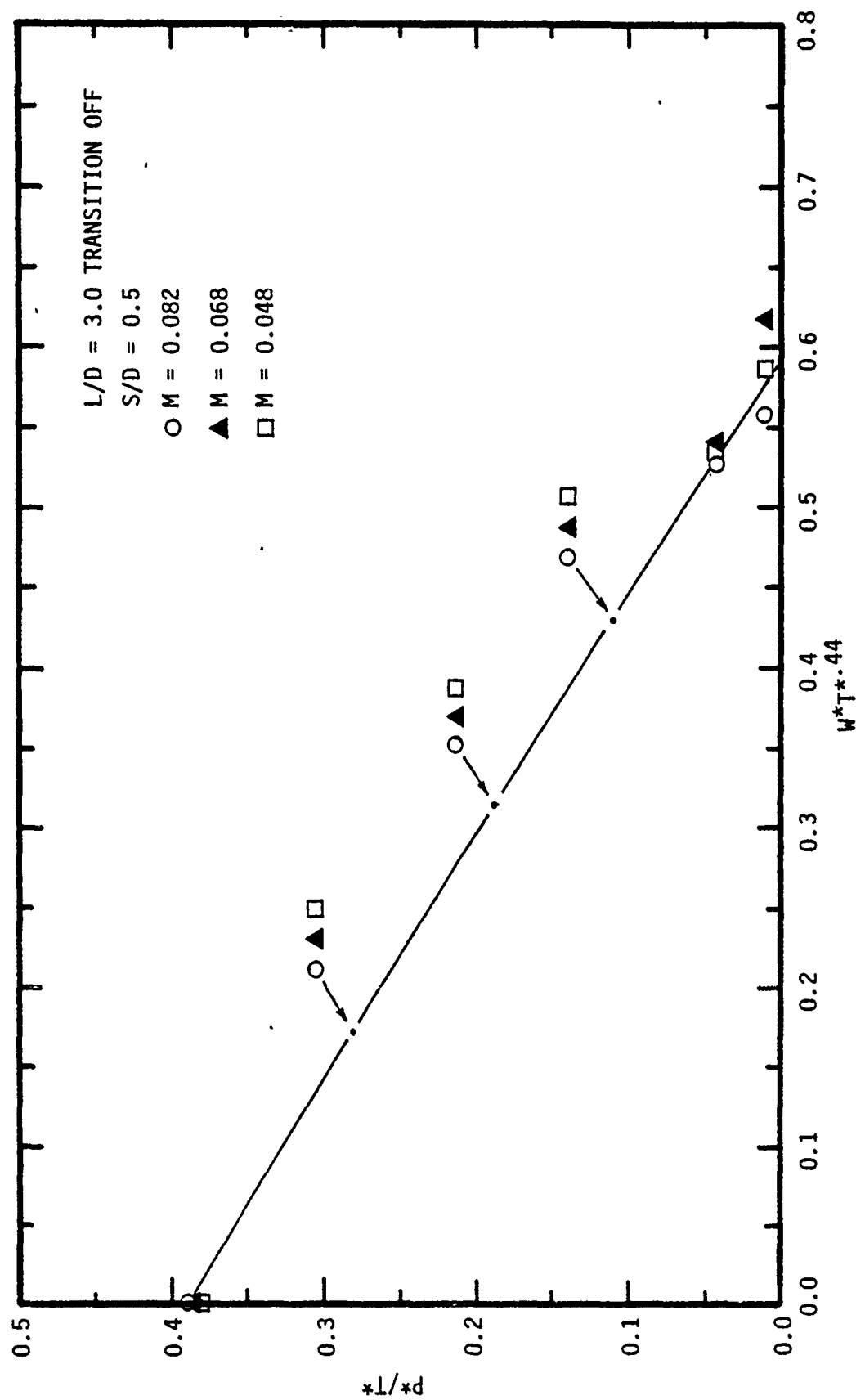


FIGURE 16. Single-Nozzle Pumping Characteristic for $L/D = 3.0$.

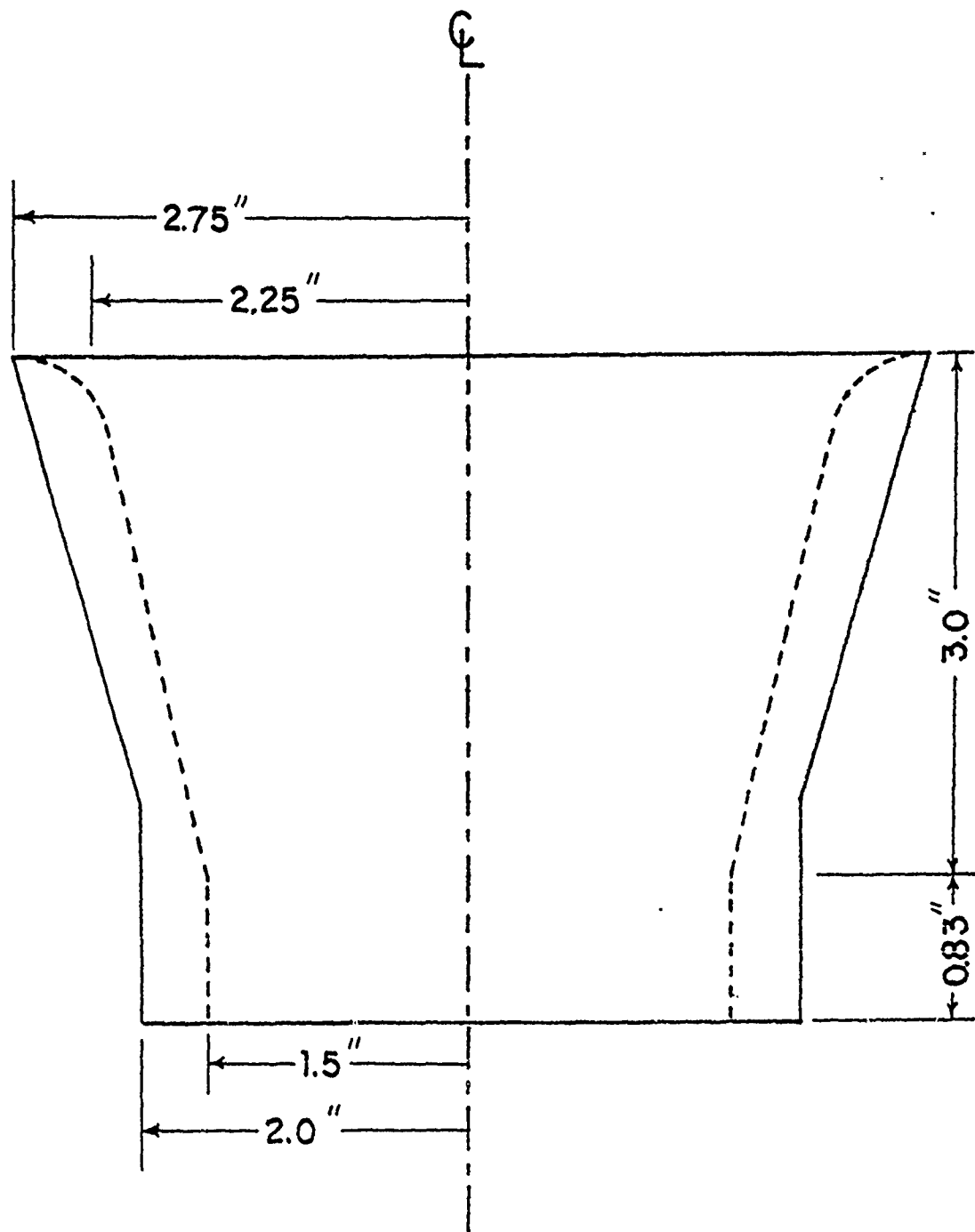


FIGURE 17. Conical Transition Geometry.



FIGURE 18. Elliptic and Con'cal Transitions.

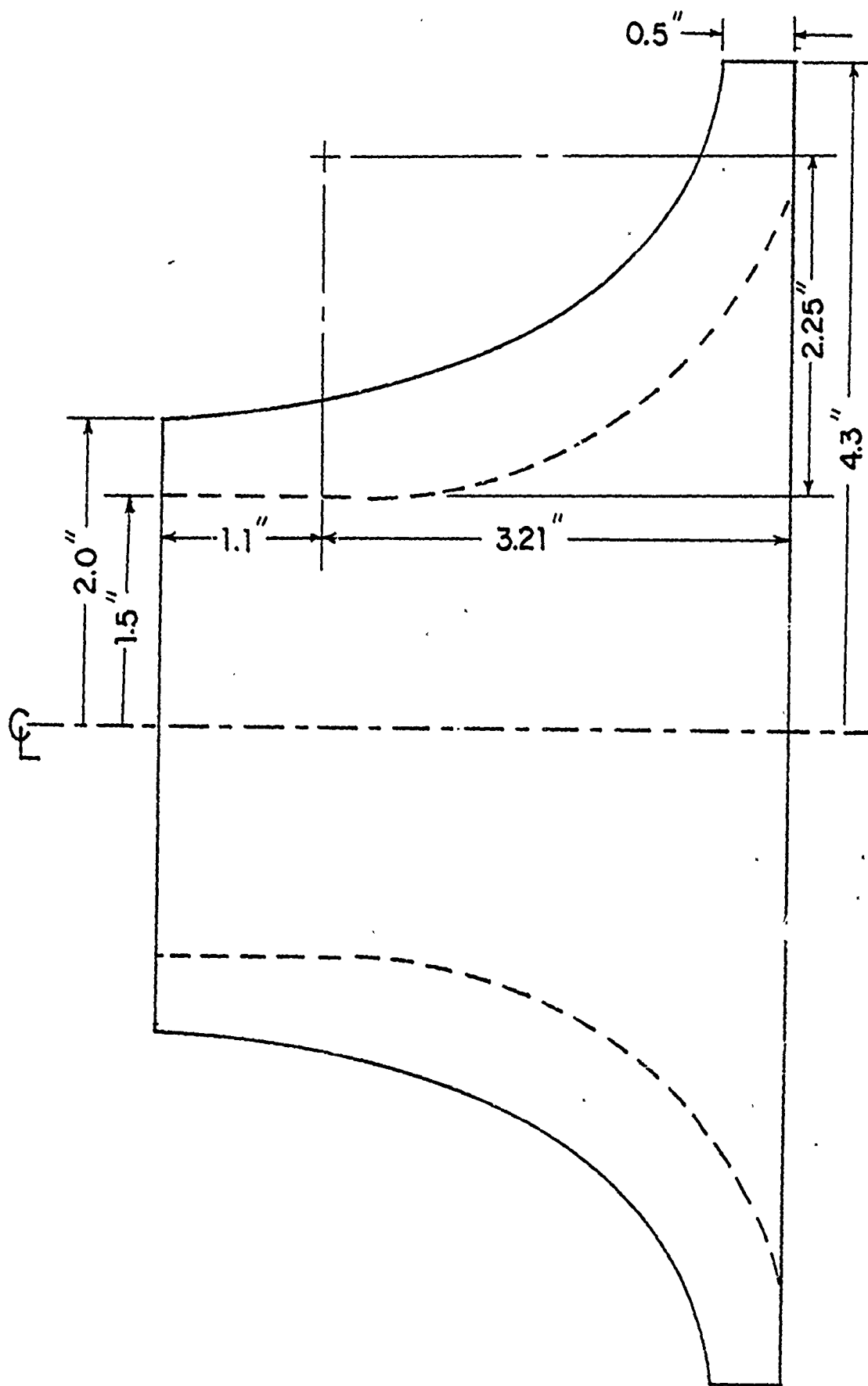


FIGURE 19. Elliptic Transition Geometry.

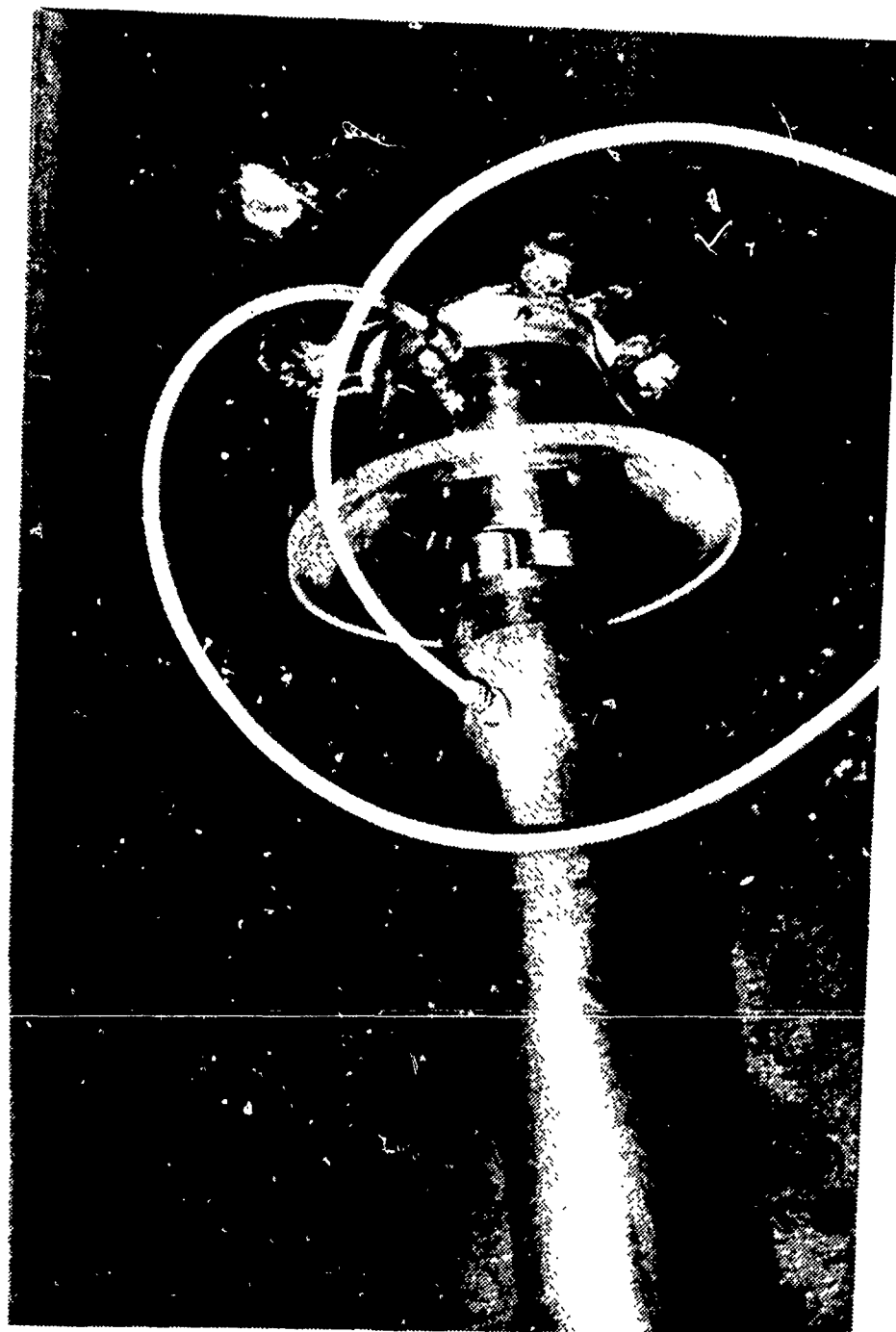
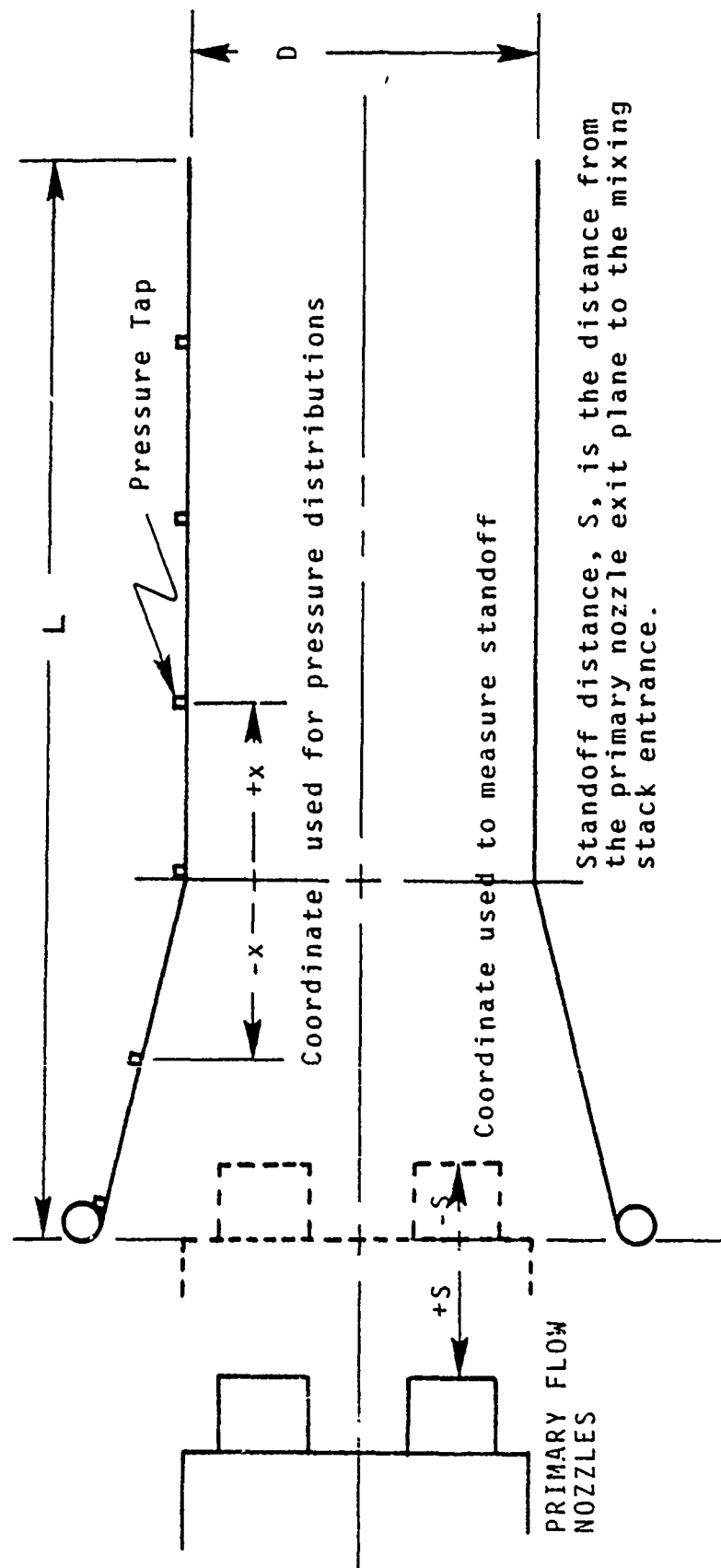


FIGURE 20. Four-Nozzle Eductor with Elliptic Transition.



Standoff distance, S , is the distance from the primary nozzle exit plane to the mixing stack entrance.

FIGURE 21. Eductor Coordinate Systems.

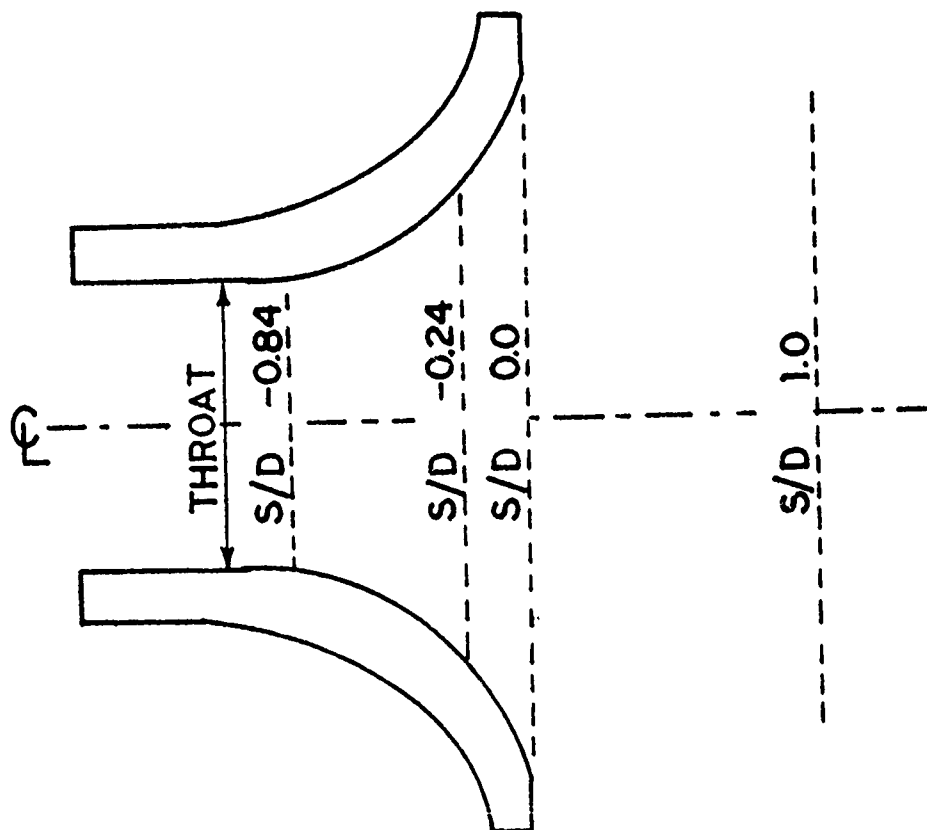


FIGURE 22. S/D Positions for Elliptic Transition.

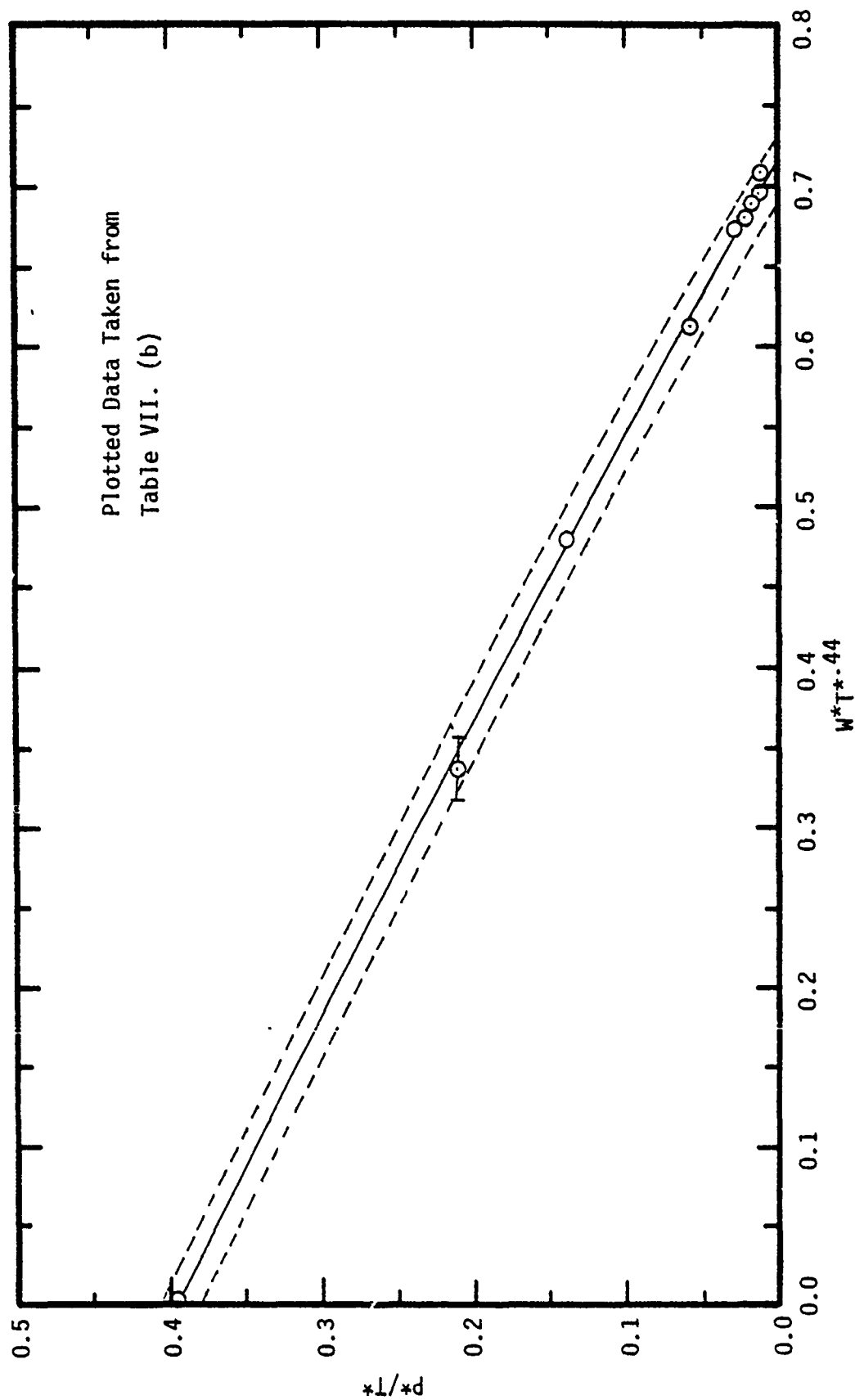


FIGURE 23. Sample Pumping Performance Curve with Uncertainty Bounds.

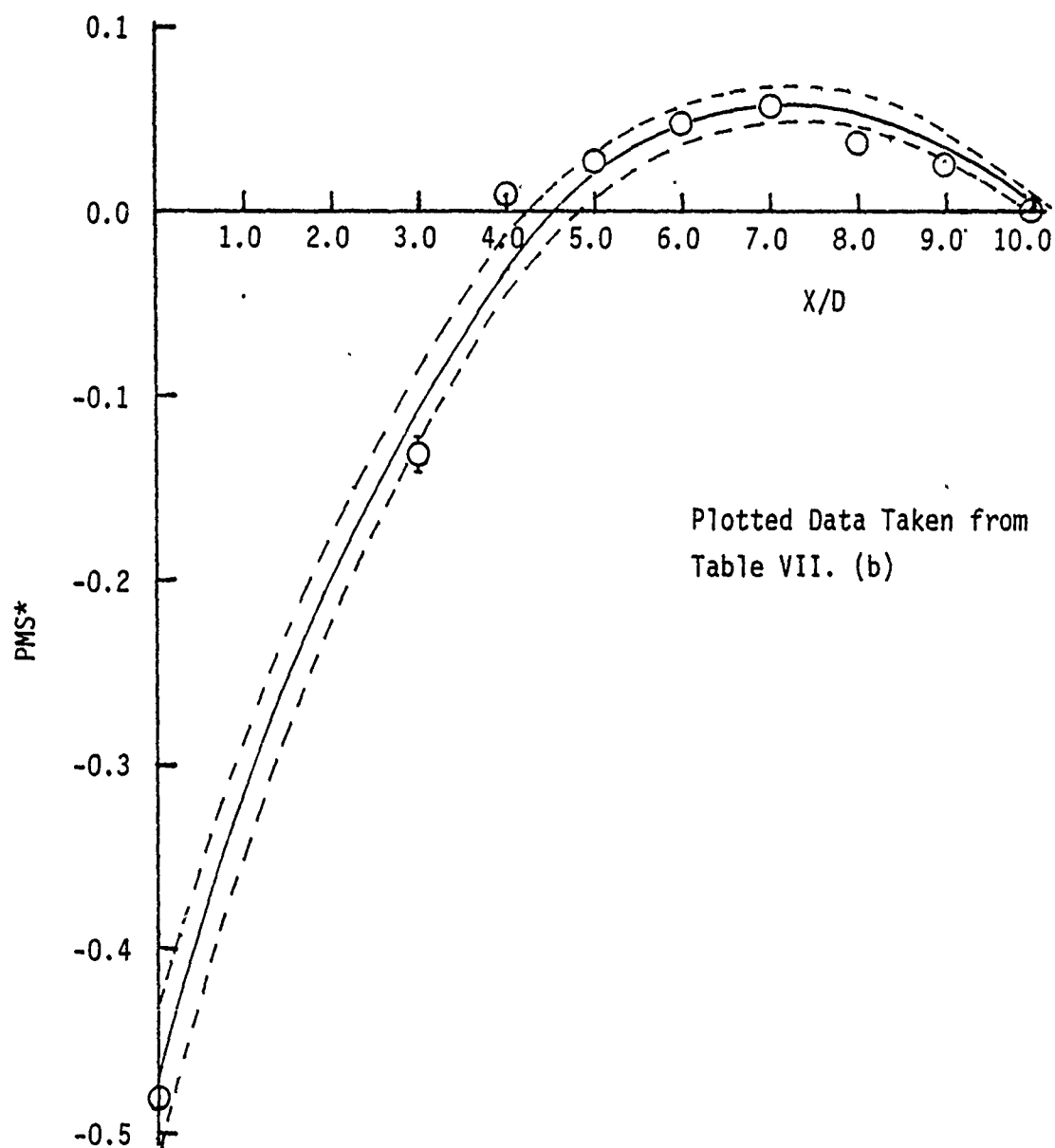


FIGURE 24. Sample Pressure Distribution Curve with Uncertainty Bounds.

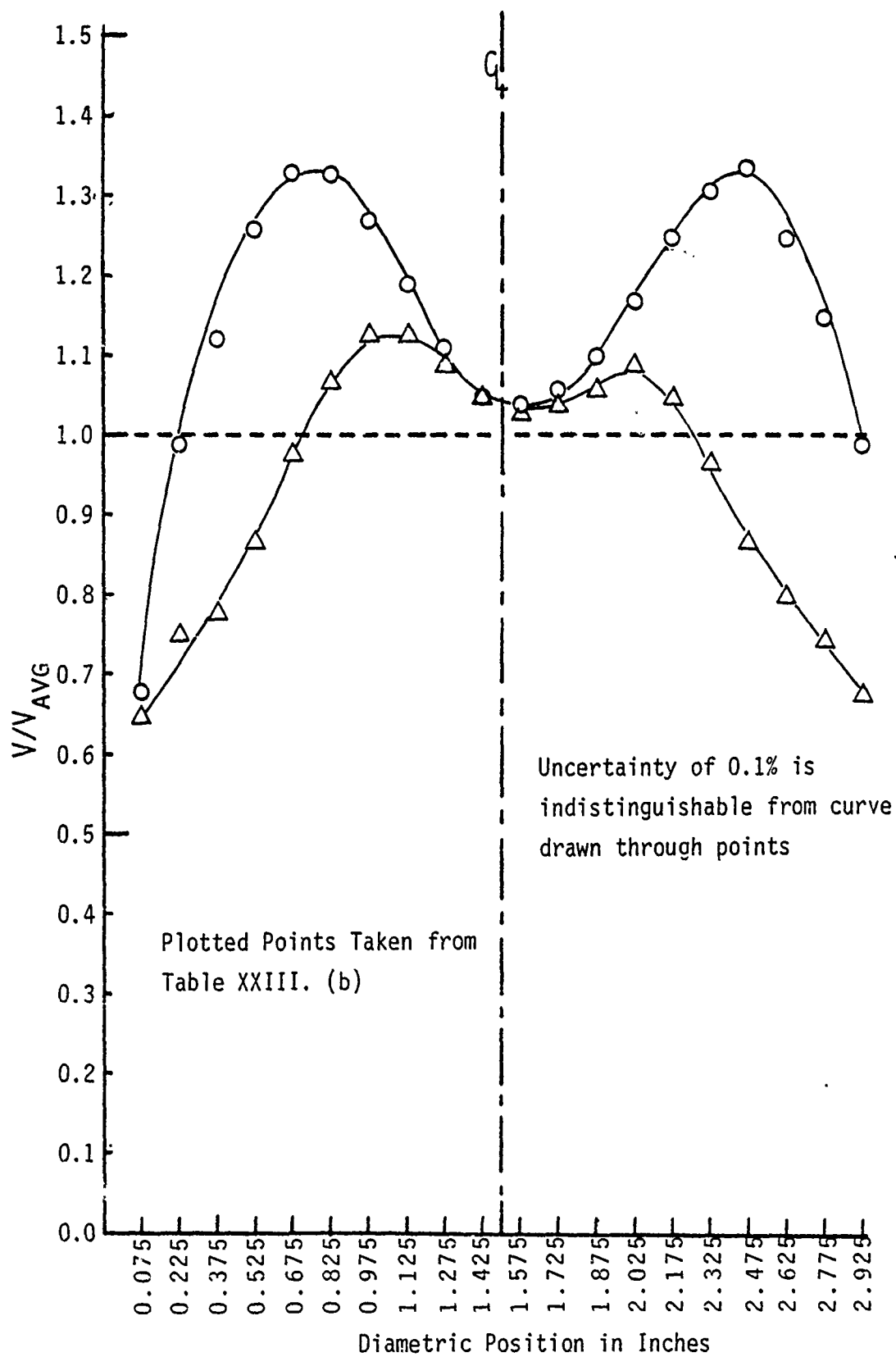


FIGURE 25. Sample Velocity Profile with Uncertainty Bounds.

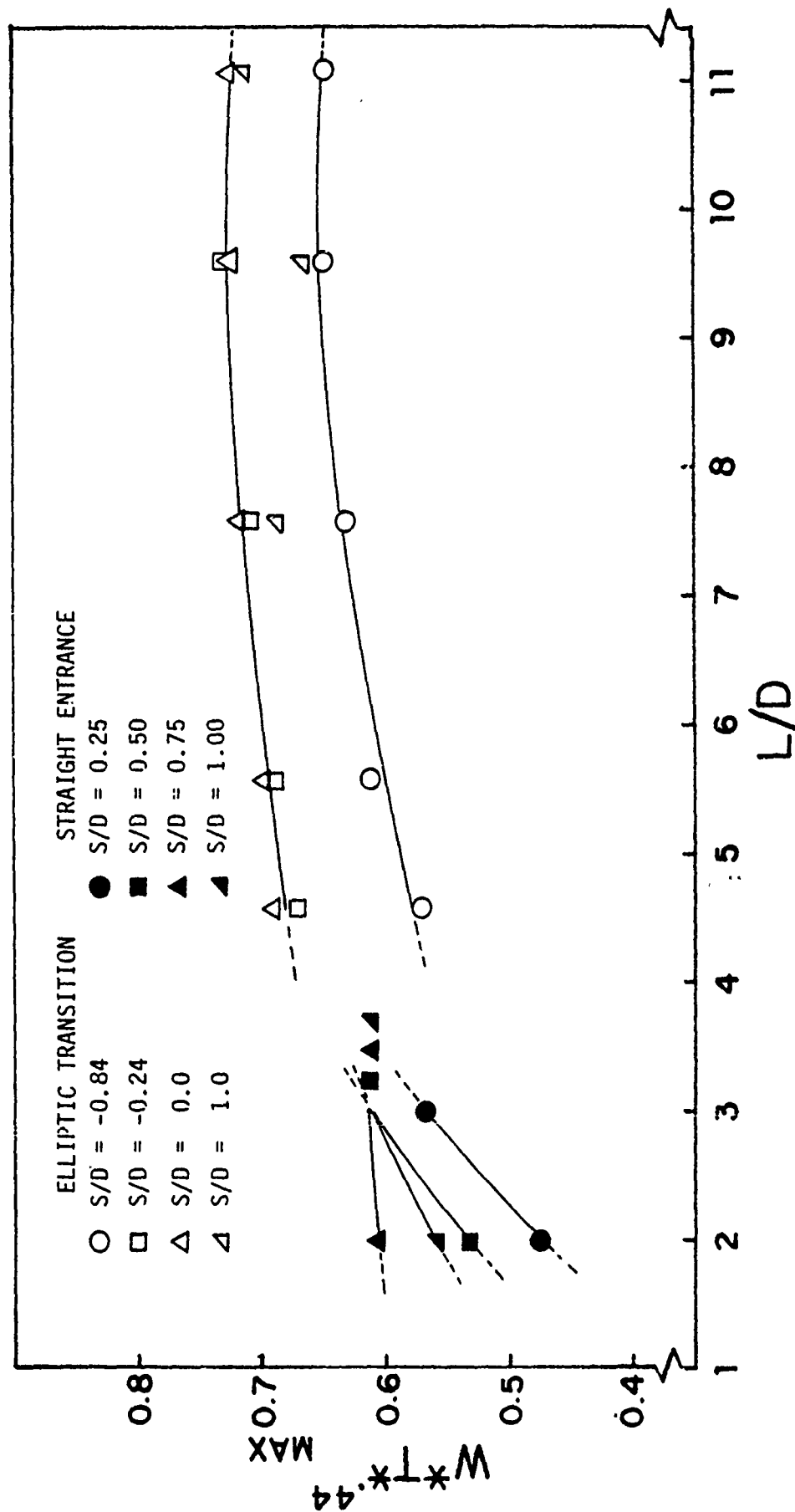


FIGURE 26. Single-Nozzle Pumping Performance Summary.

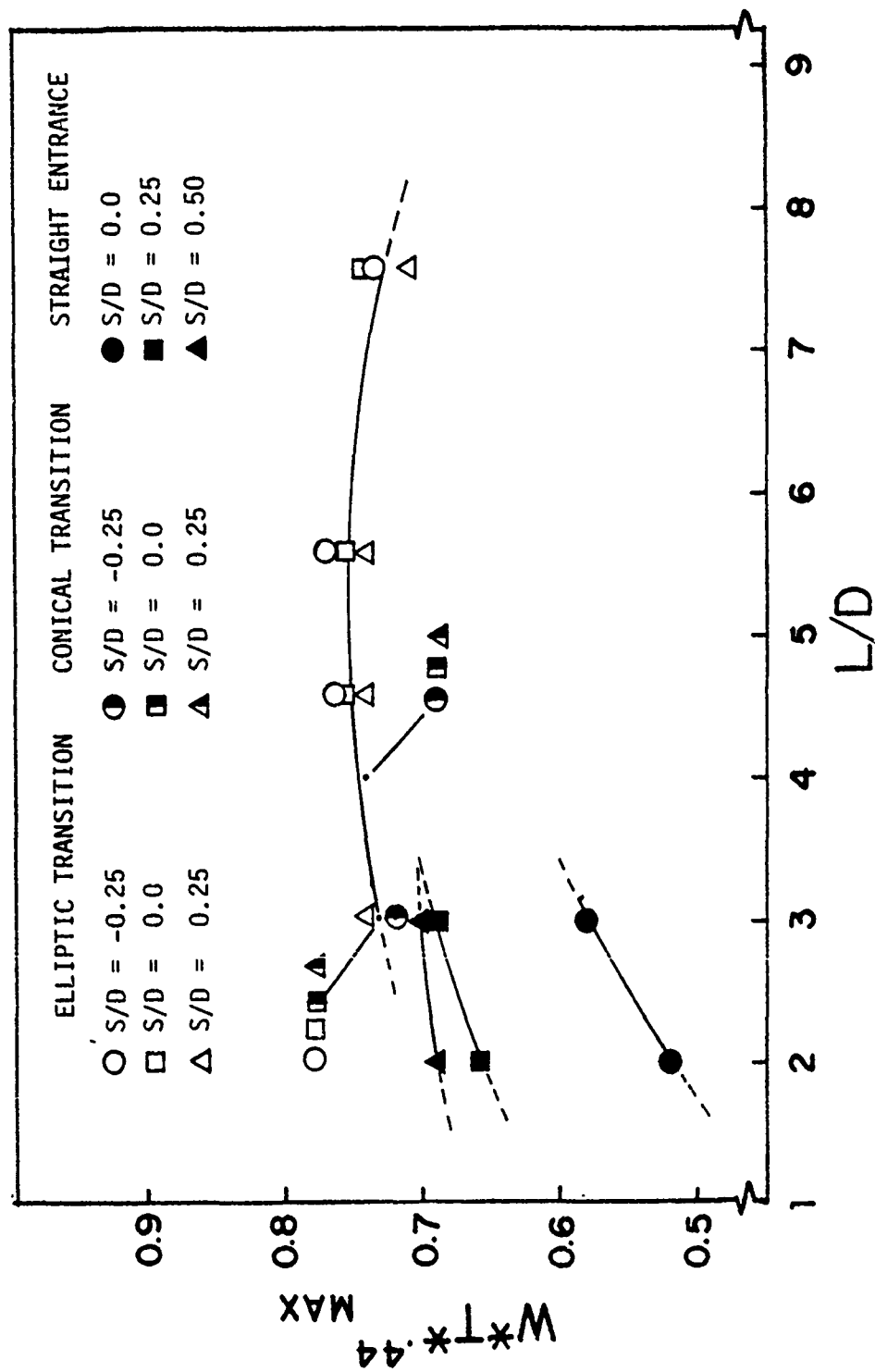


FIGURE 27. Four-Nozzle Pumping Performance Summary.

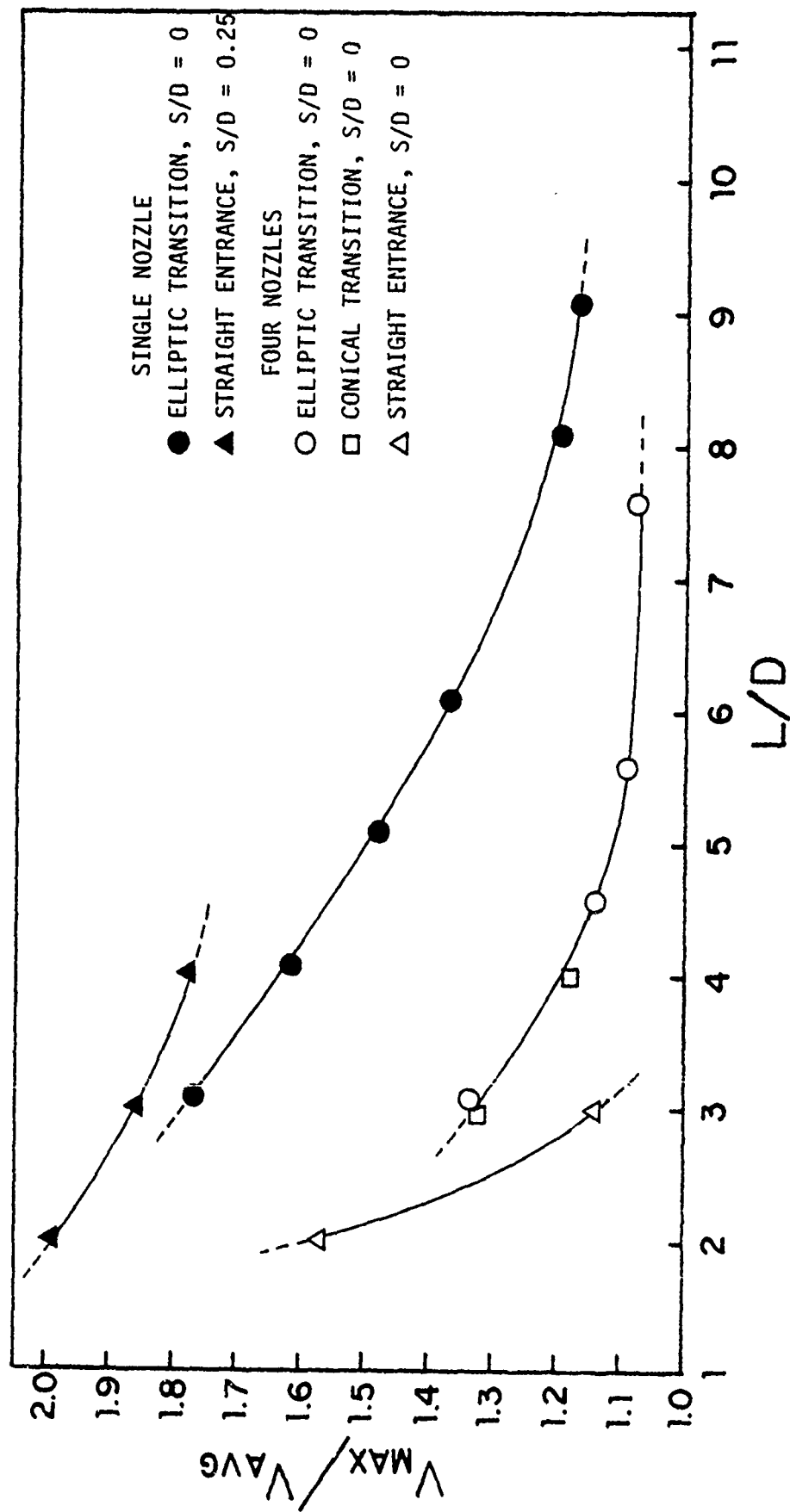


FIGURE 28. Mixing Performance of Single and Four-Nozzle Configurations, V_{\max}/V_{avg} .

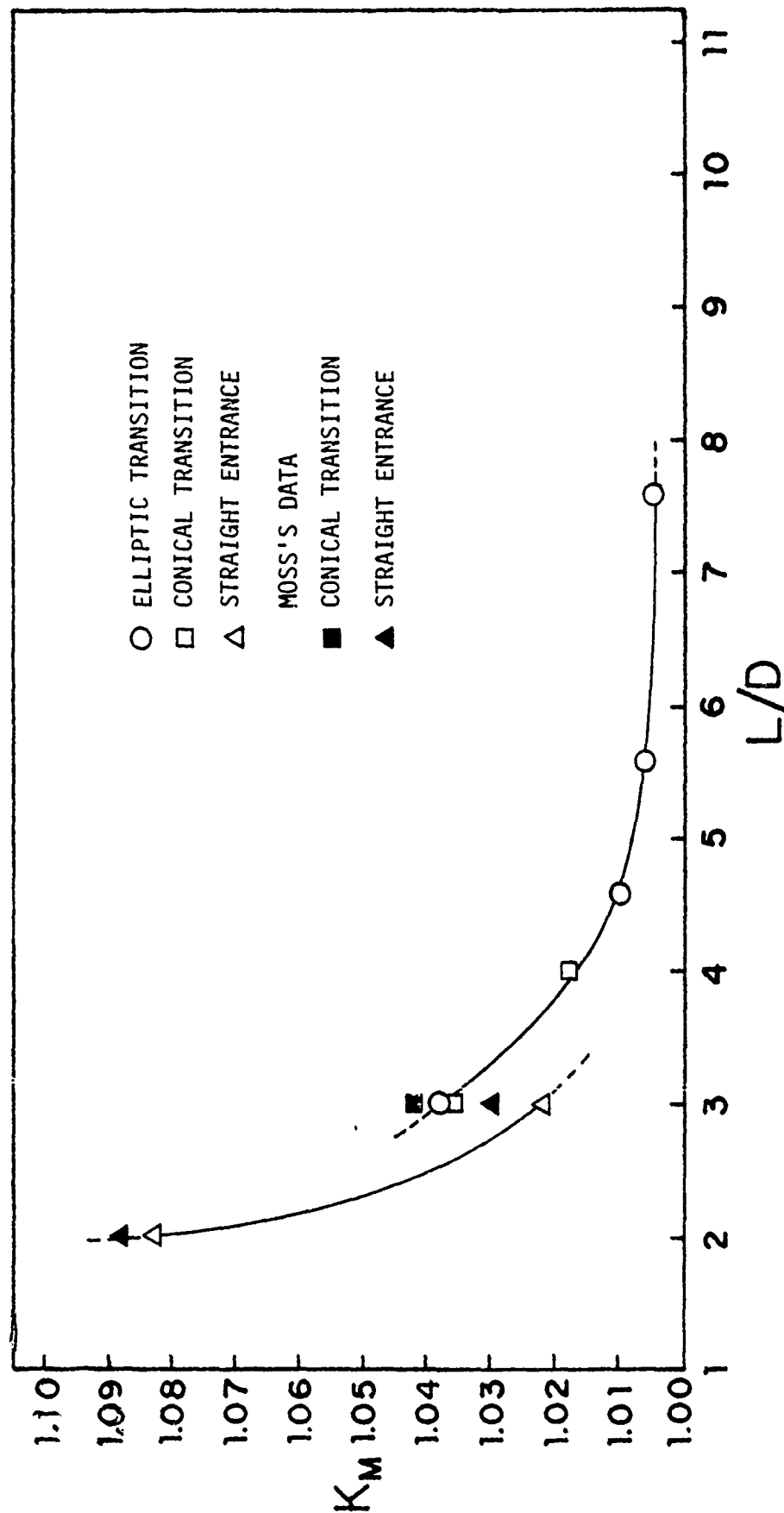


FIGURE 29. Mixing Performance of Four-Nozzle Configurations, K_M .

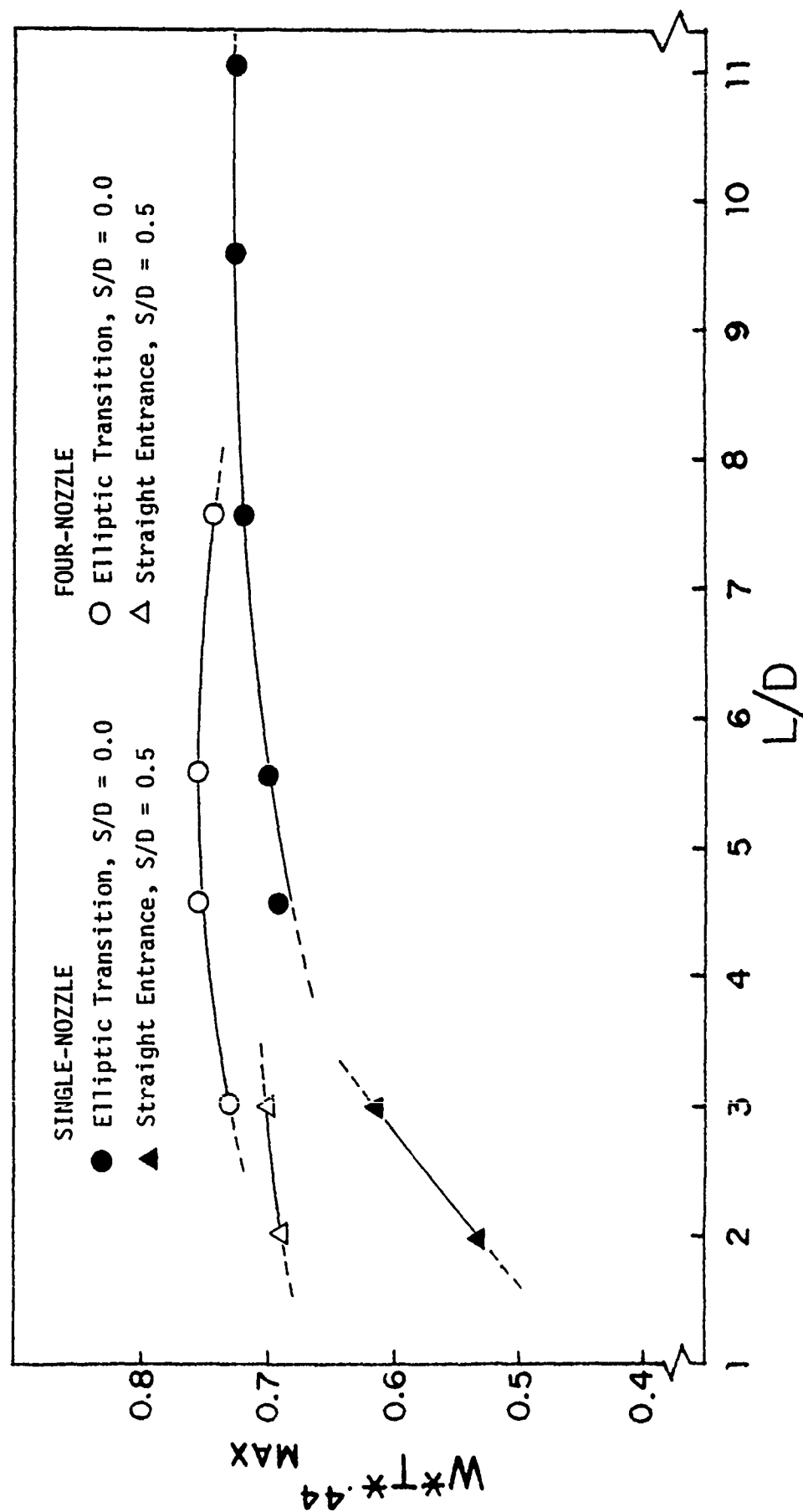
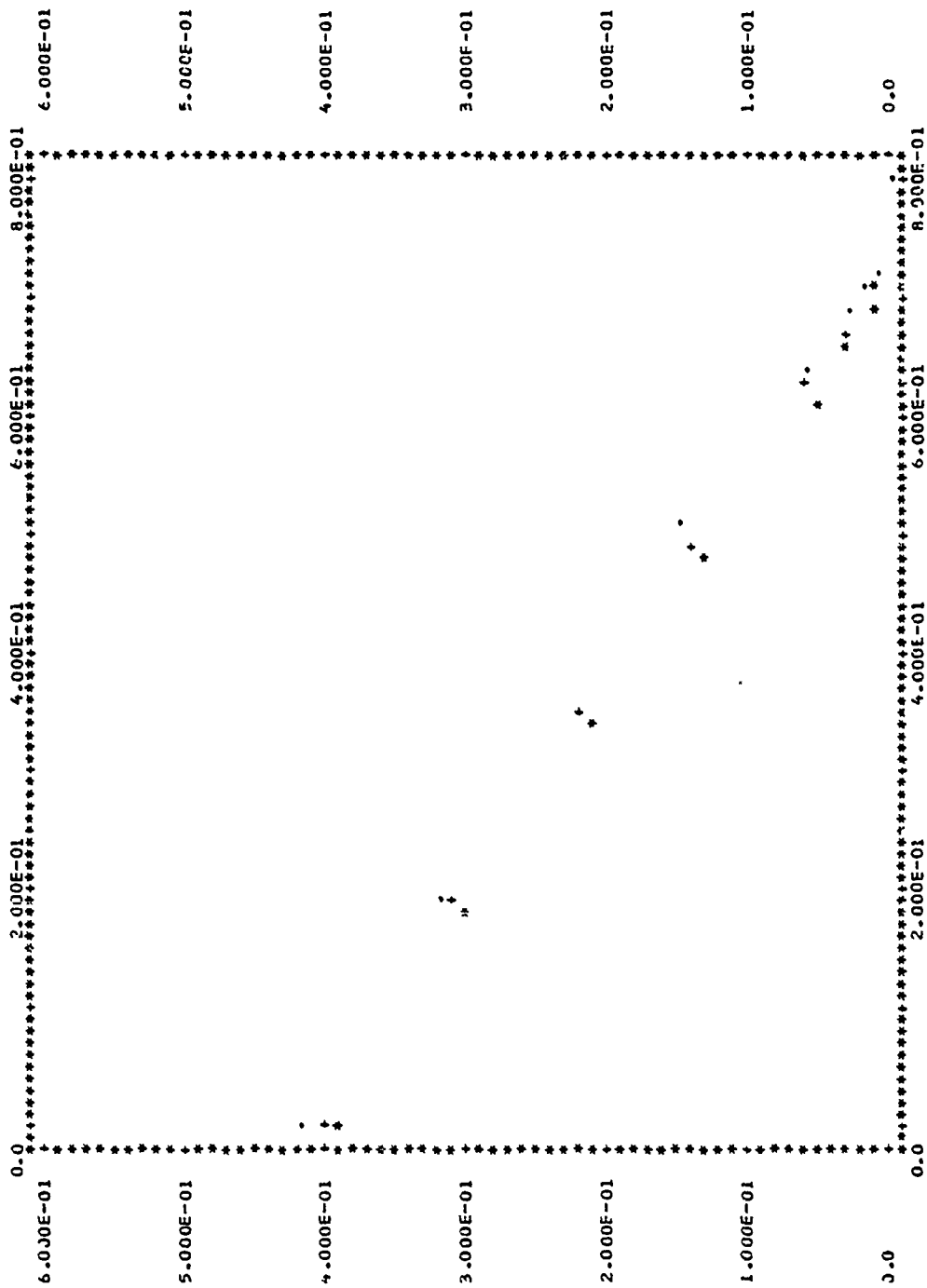


FIGURE 30. Comparison of Single-Nozzle and Four-Nozzle Pumping Performance.



NUMBER OF POINTS OUT OF RANGE = 3

P*/T* VS. WTR44 FOR L/D = 7.57

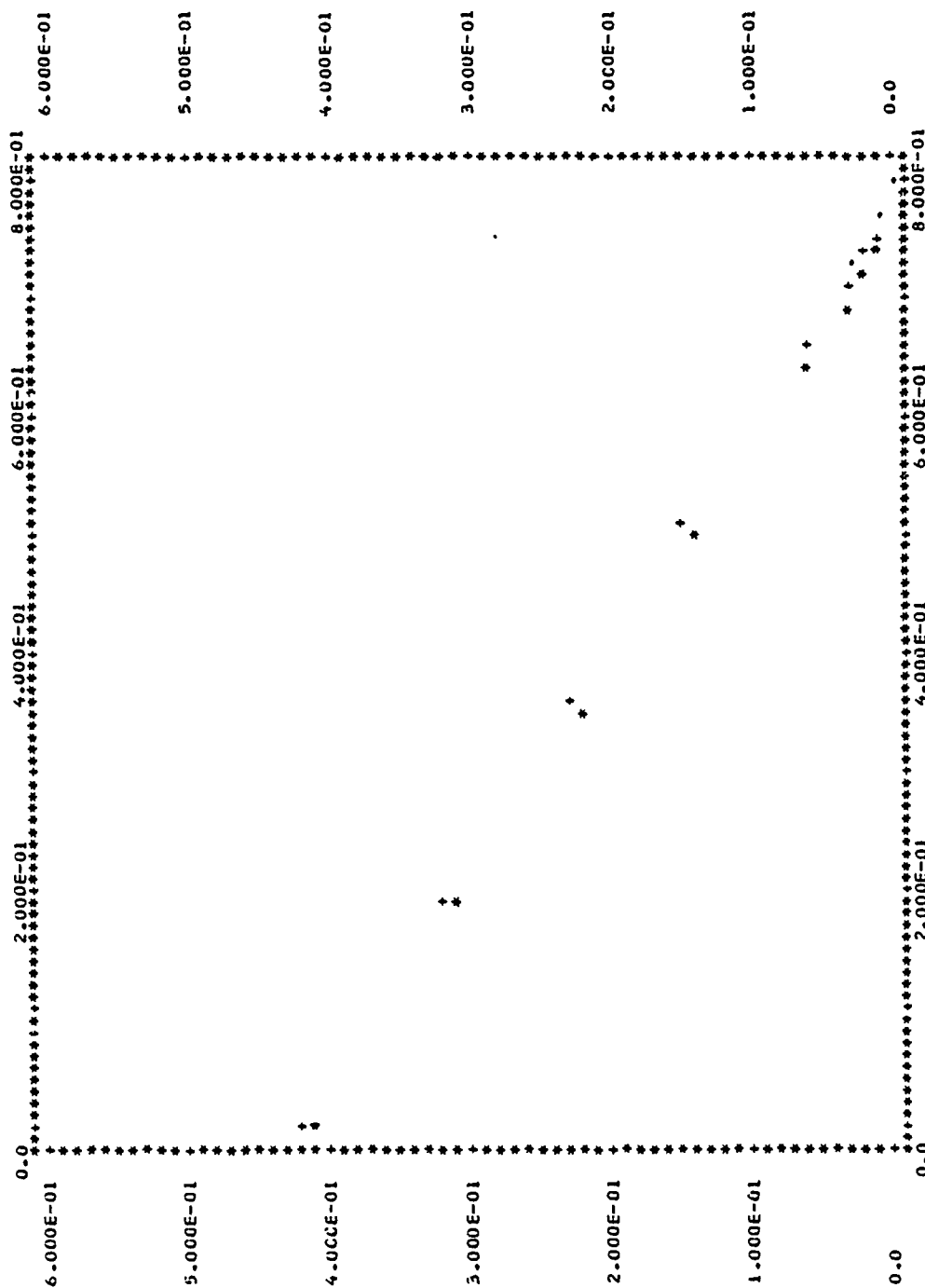
.... STANDOFF -0.25

+++ STANDOFF 0.0

*** STANDOFF 0.25

(a) L/D = 7.57

FIGURE 31. Effects of S/D on Pumping Performance for Four Nozzles, Elliptic Transition, $M_u = 0.068$.



NUMBER OF POINTS CLY OF RANGE = 3

P*/T* VS. WTK44 FOR L/D = 5.57

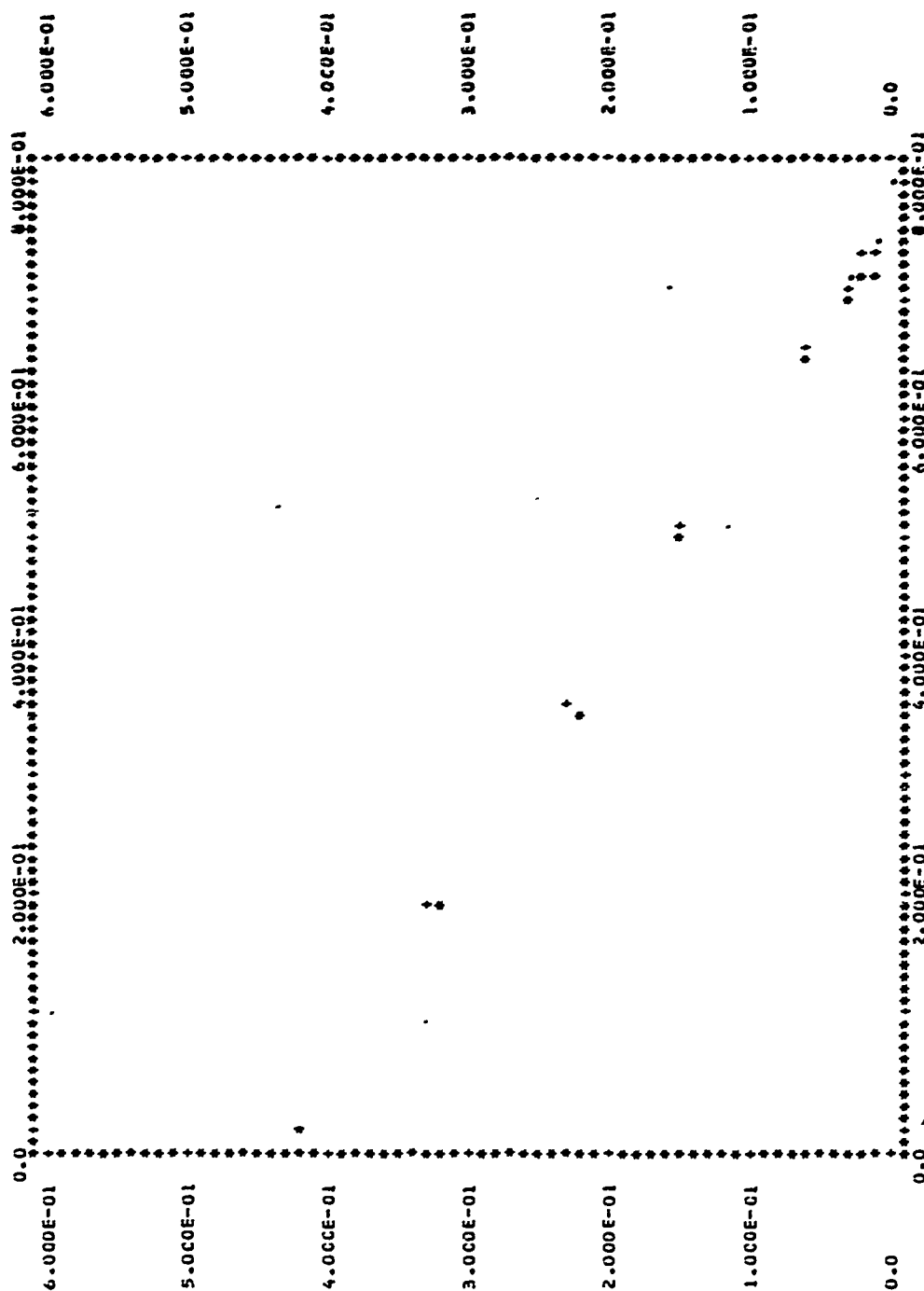
.... STANDOFF -0.25

++++ STANDOFF 0.0

**** STANDOFF 0.25

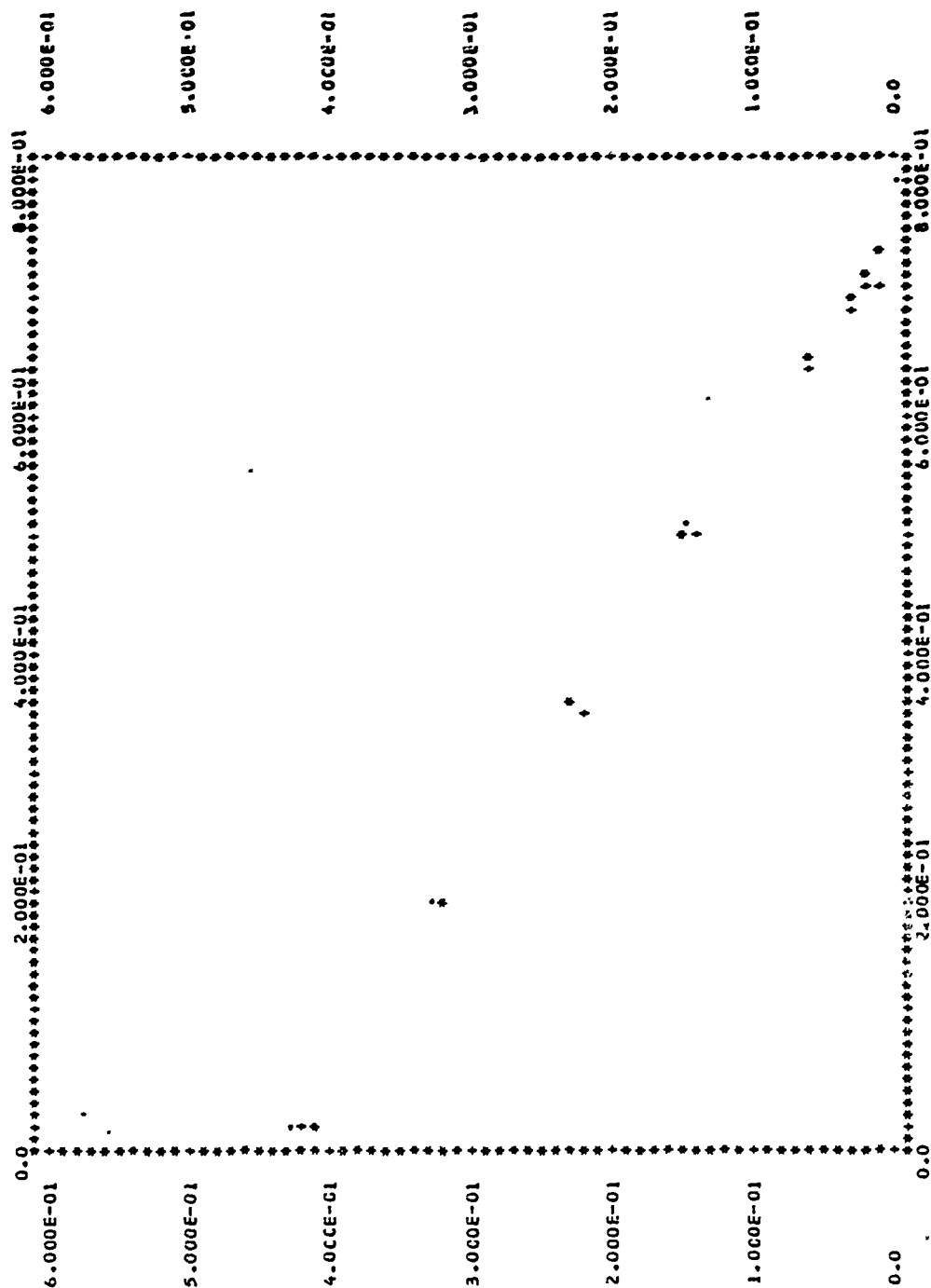
(b) L/D = 5.57

FIGURE 31. Continued.



NUMBER OF POINTS CLT OF RANGE = 3
P*1* VS. WTR44 FOR L/D = 4.57

(c) L/D = 4.57
FIGURE 31. Continued.



NUMBER OF POINTS L/D OF RANGE = 3

P^*IT^* VS. $WTR44$ FOR $L/D = 3.00$

.... STANDOFF -0.25

+++ STANDOFF 0.0

*** STANDOFF 0.25

(d) $L/D = 3.0$

FIGURE 31. Continued.

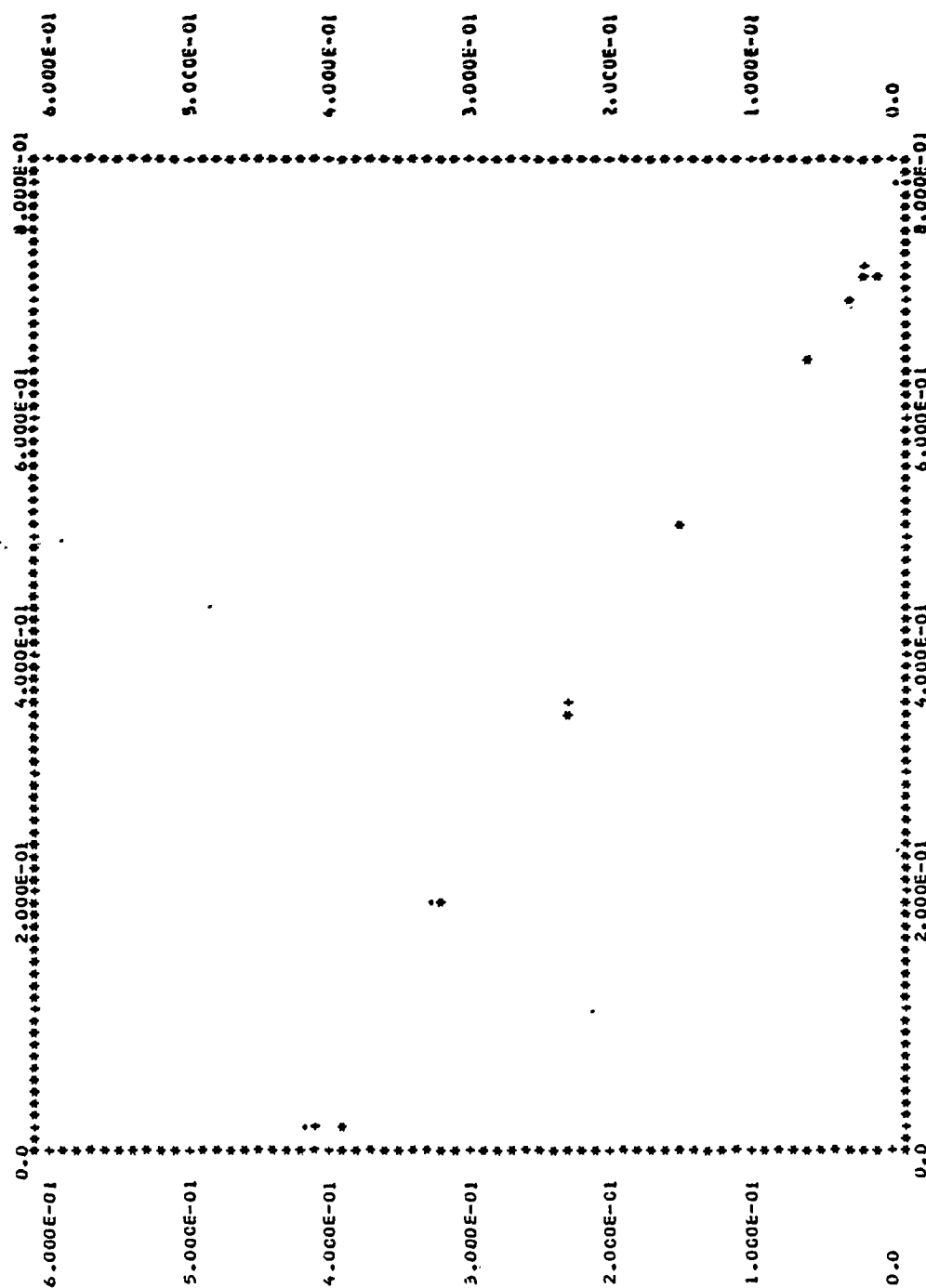
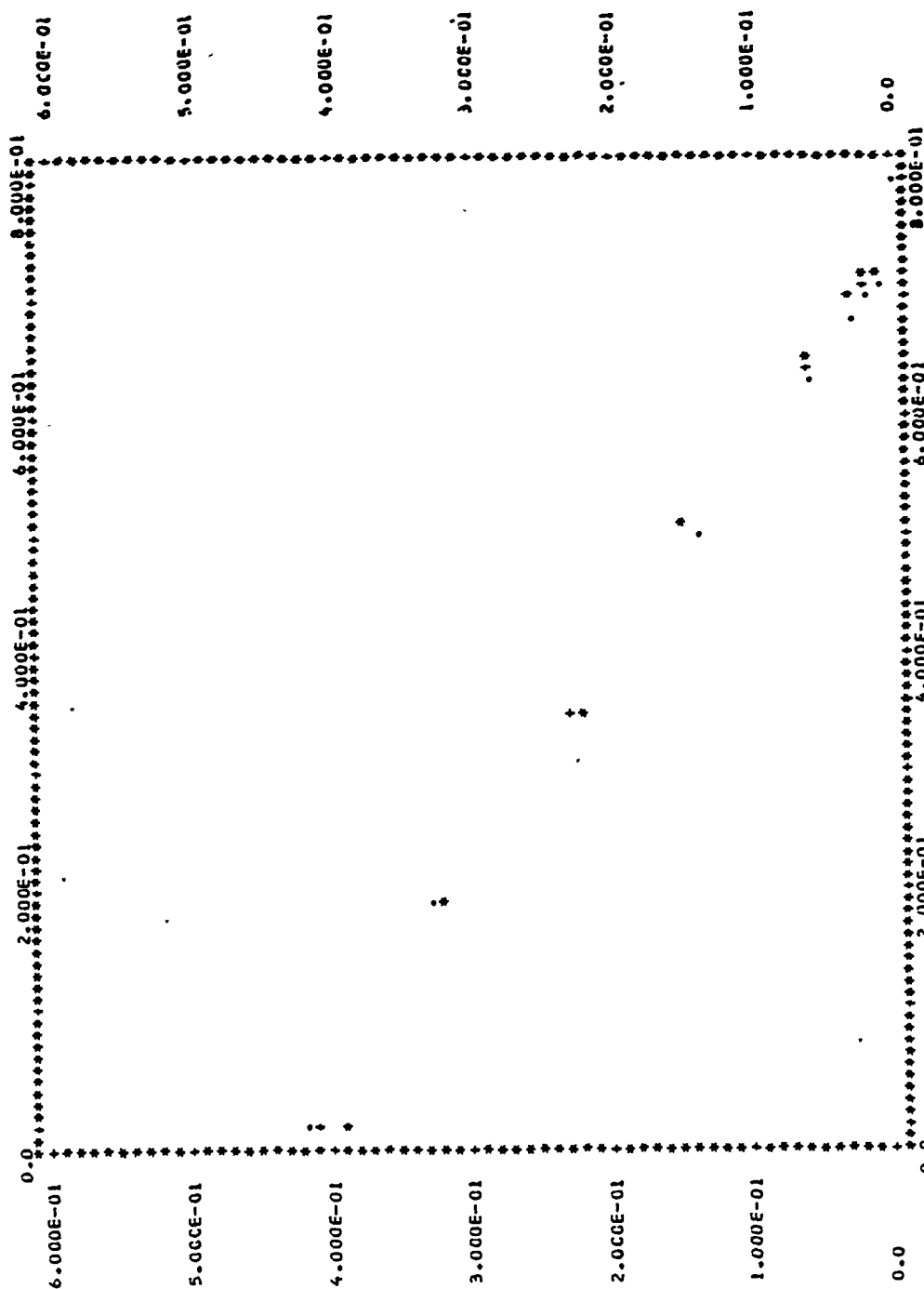
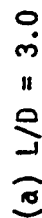


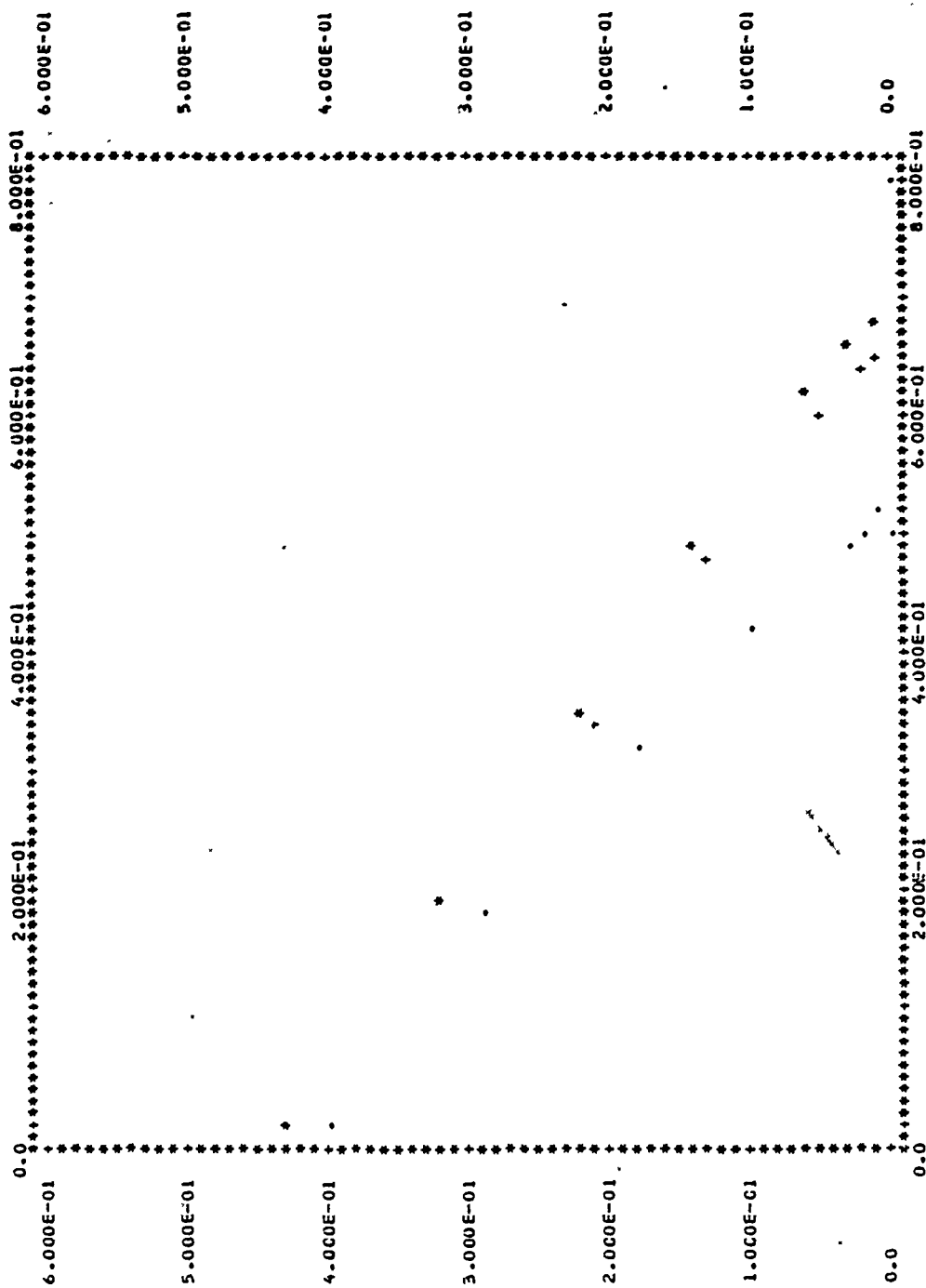
FIGURE 32. Effects of S/D on Pumping Performance for Four Nozzles, Conical Transition, $M_u = 0.068$.



(b) L/D = 3.0
FIGURE 32. Continued.



99



NUMBER OF POINTS CUT OF RANGE = 3

P*/T* VS. WTR44 FOR L/D = 2.00

..... STANDOFF -0.25

++++ STANDOFF 0.0

**** STANDOFF 0.25

(b) L/D = 2.0

FIGURE 33. Continued.

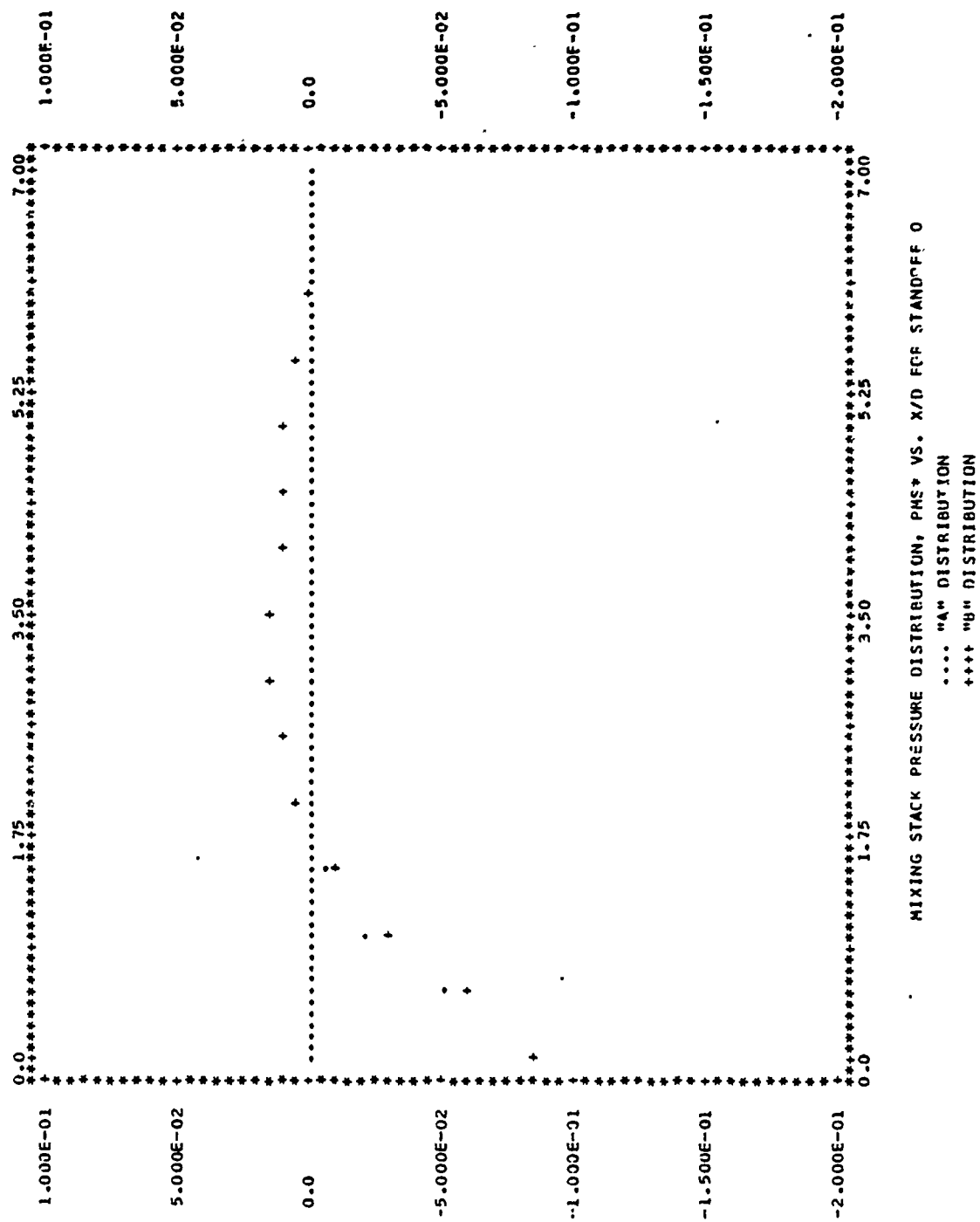


FIGURE 34. Mixing Stack Pressure Distributions for Four Nozzles, Elliptic Transition, $M_u = 0.068$.

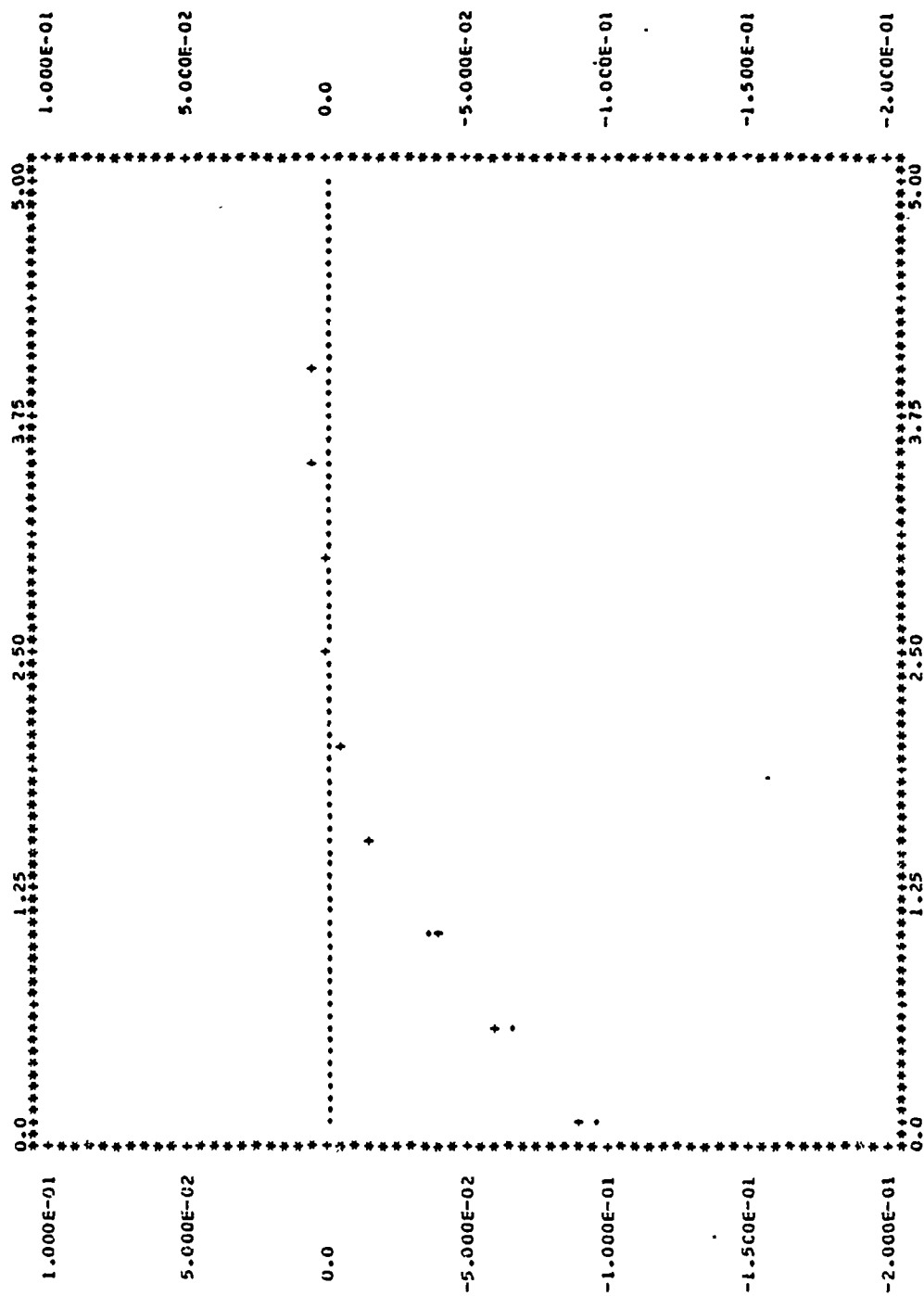
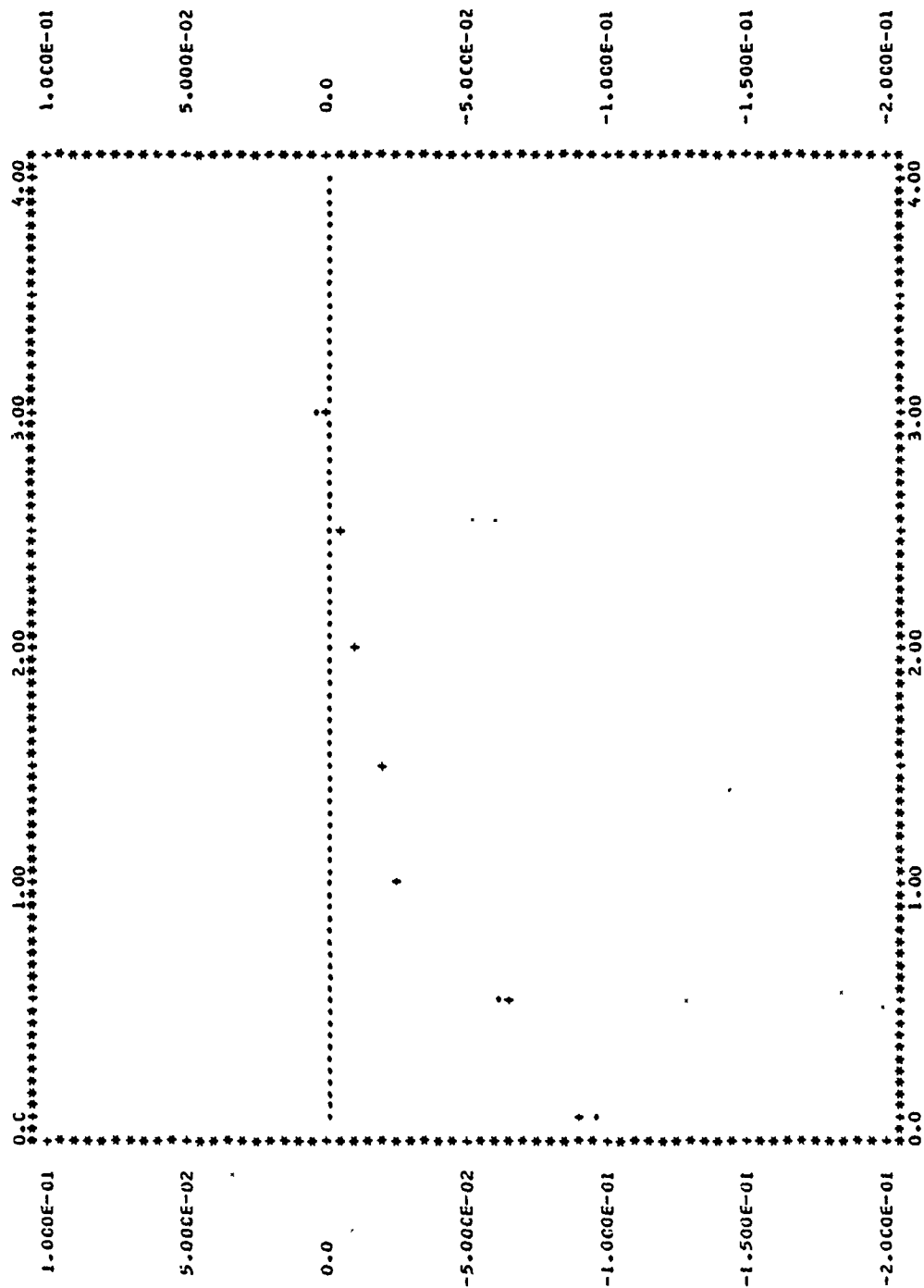


FIGURE 34. Continued.



MIXING STACK PRESSURE DISTRIBUTION, PMS* VS. X/D FOR STANDOFF 0

---- "A" DISTRIBUTION

++++ "B" DISTRIBUTION

(c) L/D = 4.57

FIGURE 34. Continued.

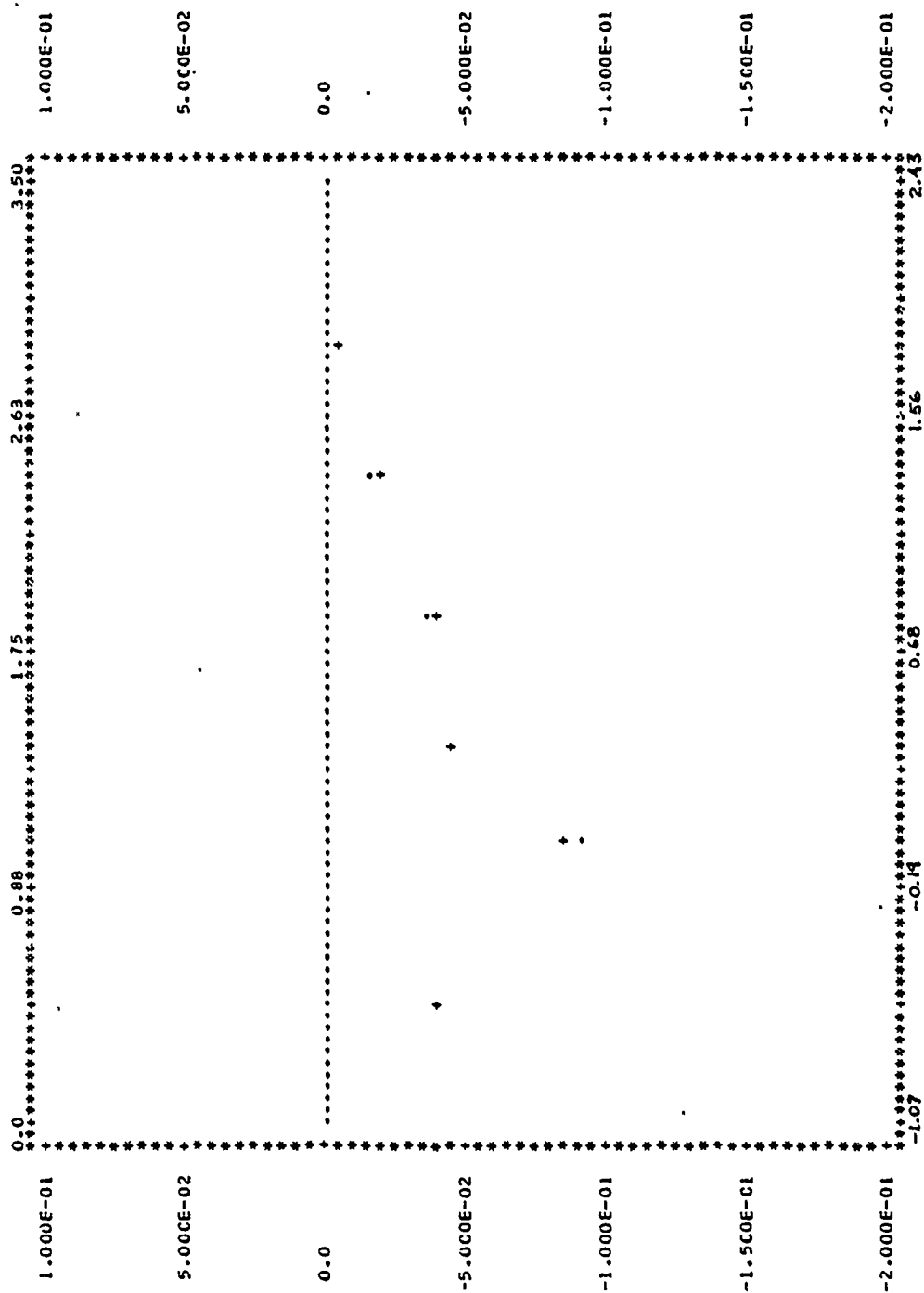
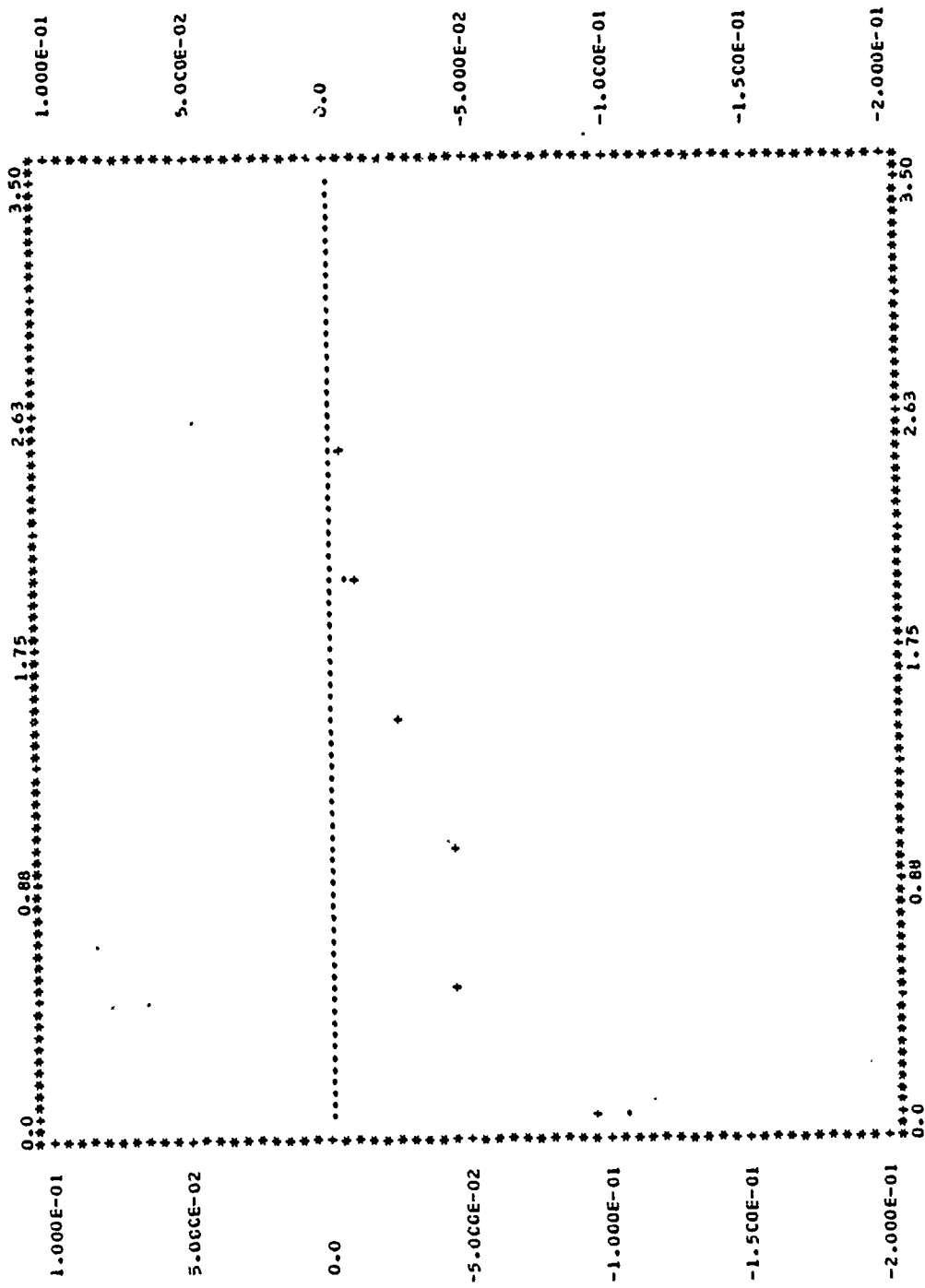


FIGURE 34. Continued.



MIXING STACK PRESSURE DISTRIBUTION, PMS* VS. X/D FOR STANDOFF 0

.... "A" DISTRIBUTION

+++ "B" DISTRIBUTION

(a) L/D = 4.0

FIGURE 35. Mixing Stack Pressure Distributions for Four Nozzles, Conical Transition, $M_u = 0.068$.

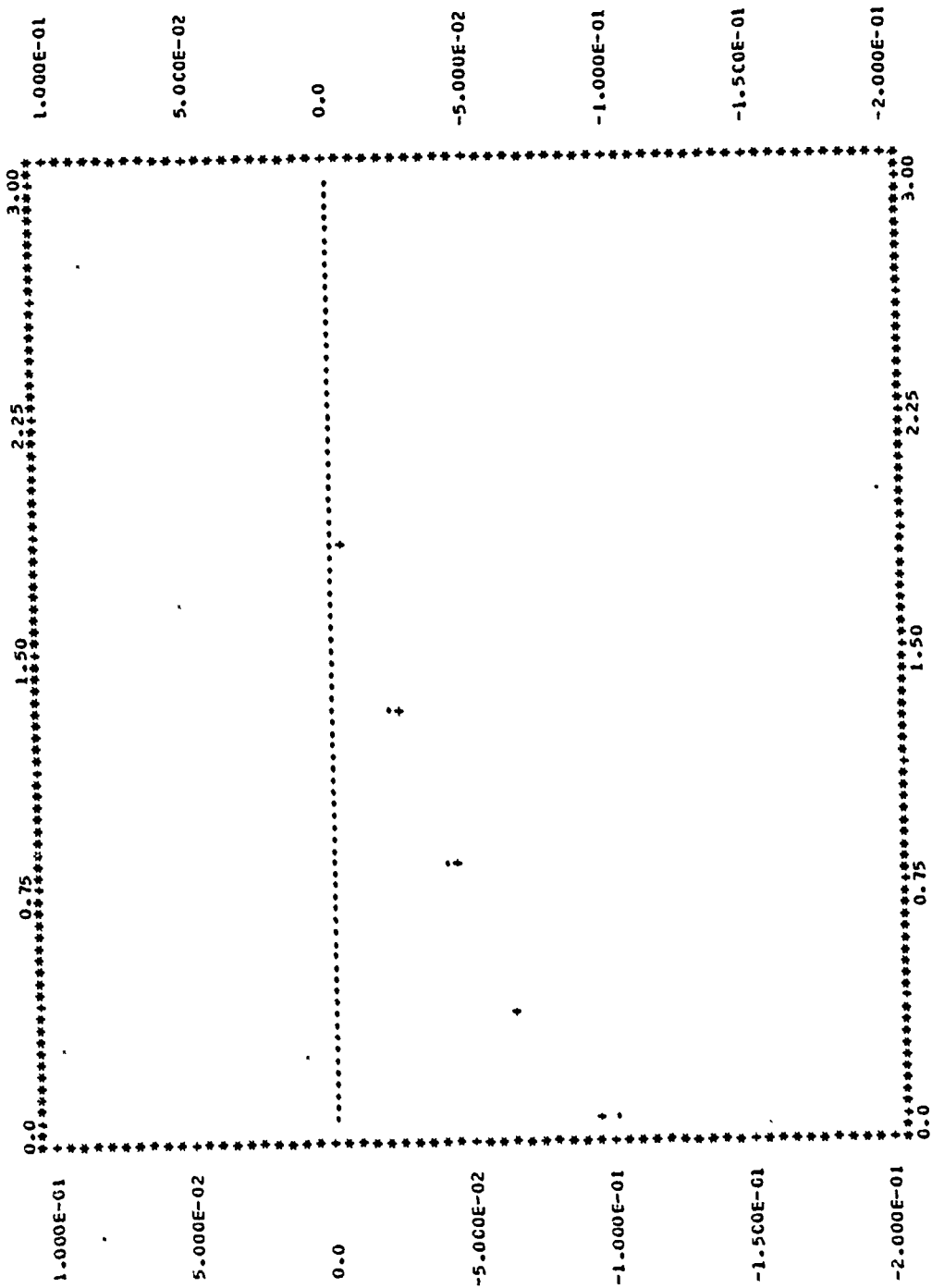


FIGURE 35. Continued.

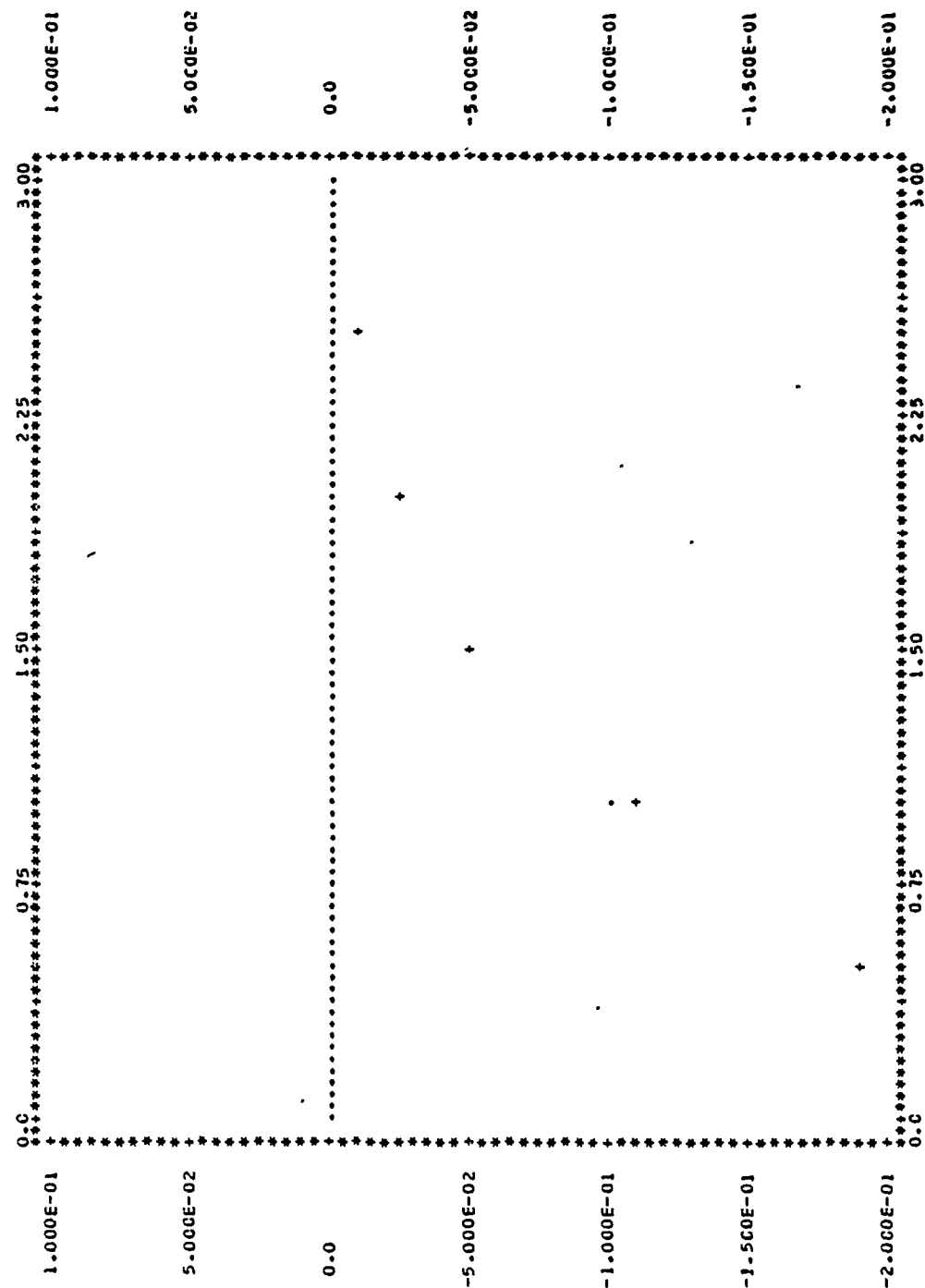


FIGURE 36. Mixing Stack Pressure Distributions for Four Nozzles, Straight Entrance, $M_u = 0.068$.

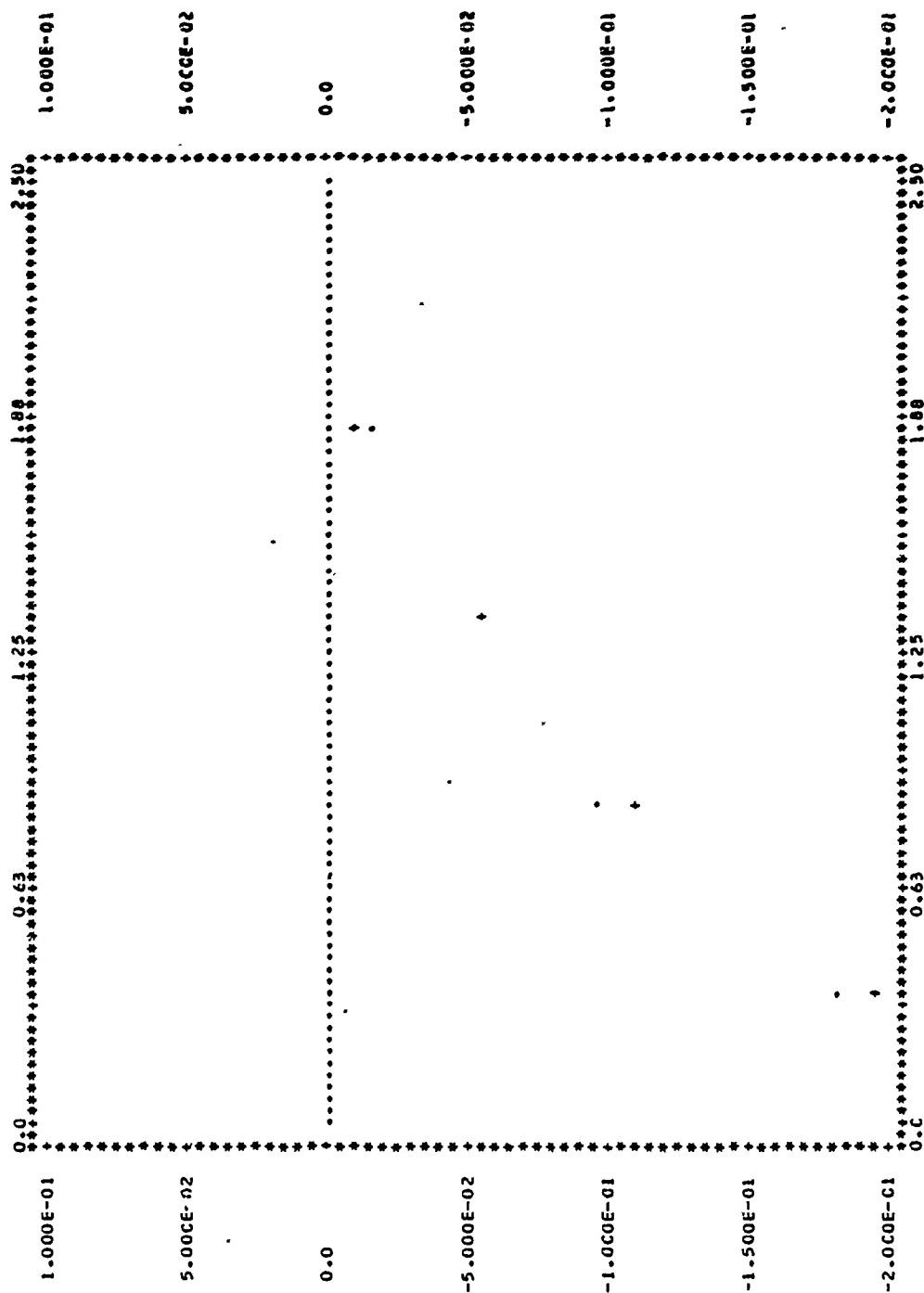
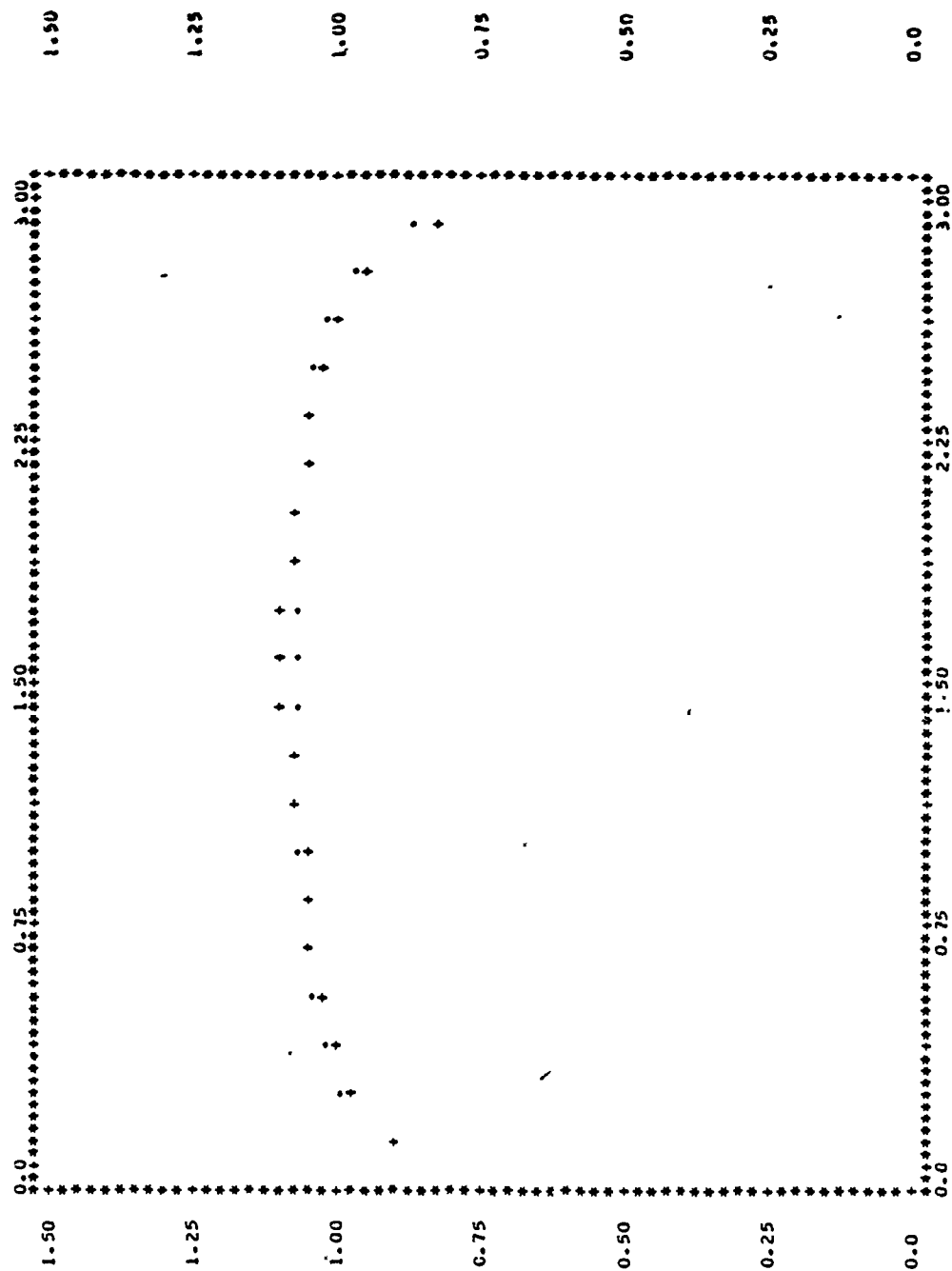


FIGURE 36. Continued.



FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0, $L/D = 7.57$

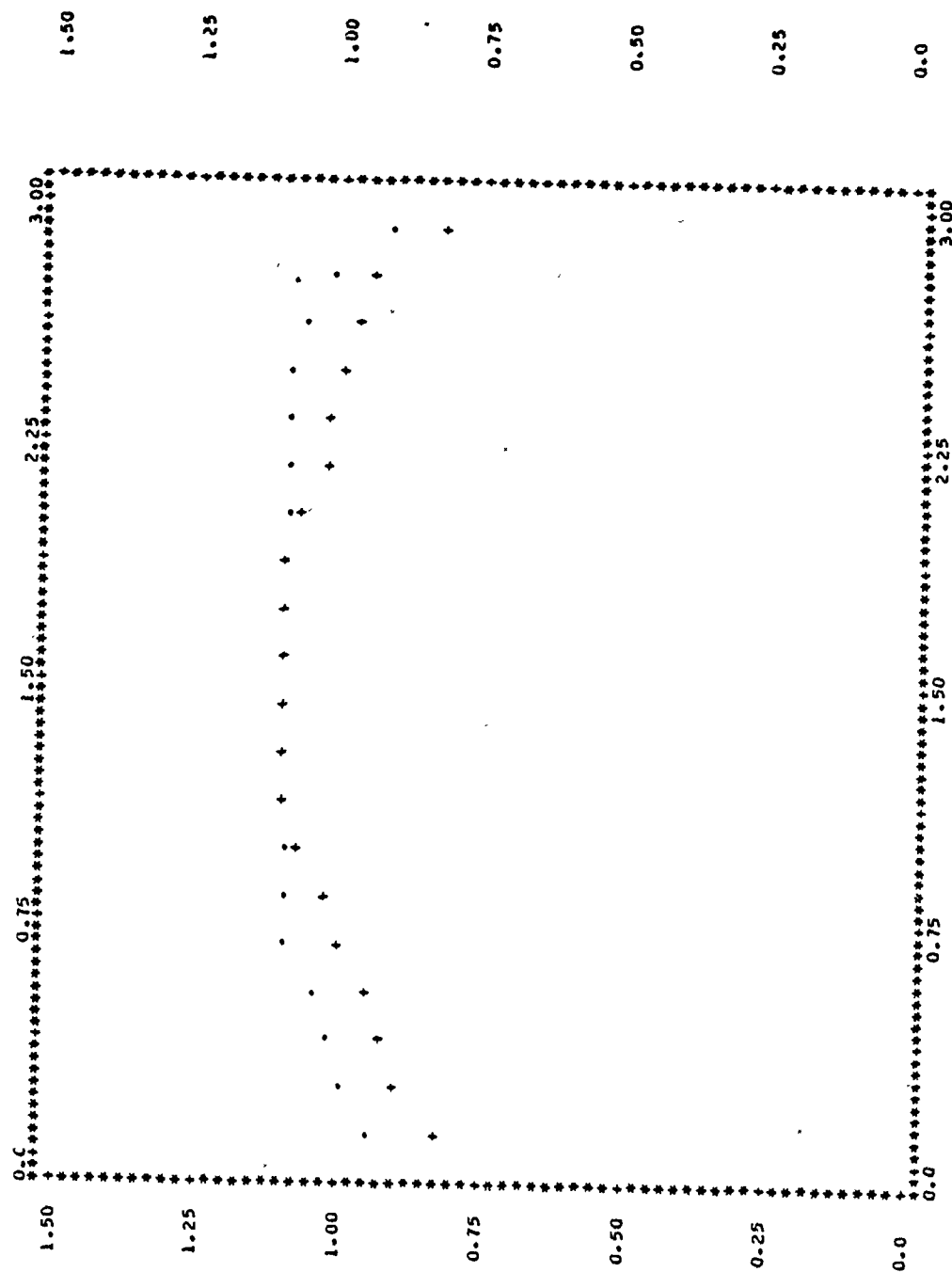
VELOCITY PROFILE AT MIXING STACK END PLANE, V/VAVG VS. X

..... A TRAVERSE

++++ B TRAVERSE

(a) $L/D = 7.57$

FIGURE 37. Mixing Stack Exit Velocity Profiles for Four Nozzles, Elliptic Transition, $M_u = 0.068$.



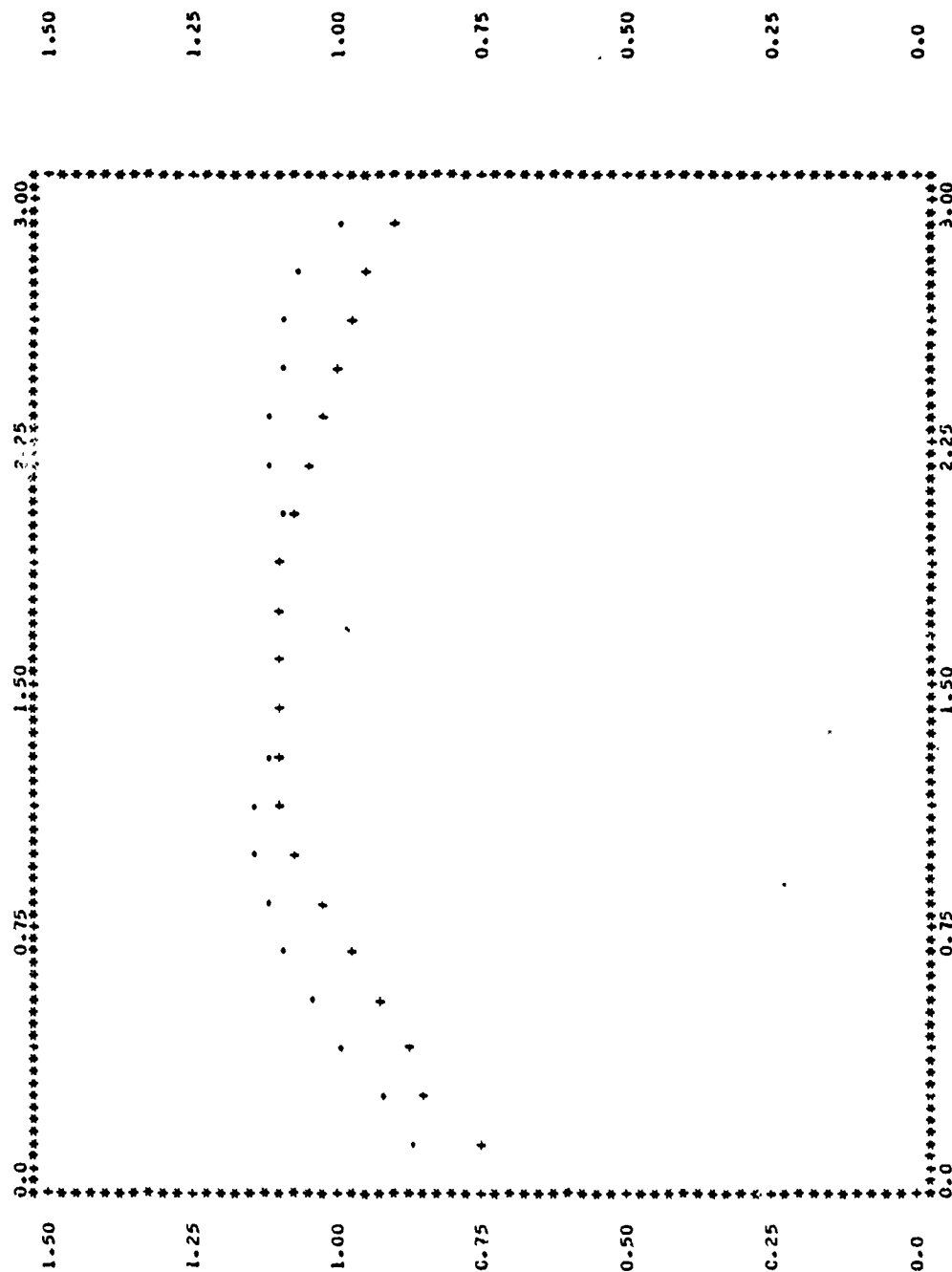
FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0, $L/D = 5.57$
 VELOCITY PROFILE AT MIXING STACK END PLANE, V/V_{AVG} VS. X

.... A TRAVERSE

++++ B TRAVERSE

(b) $L/D = 5.57$

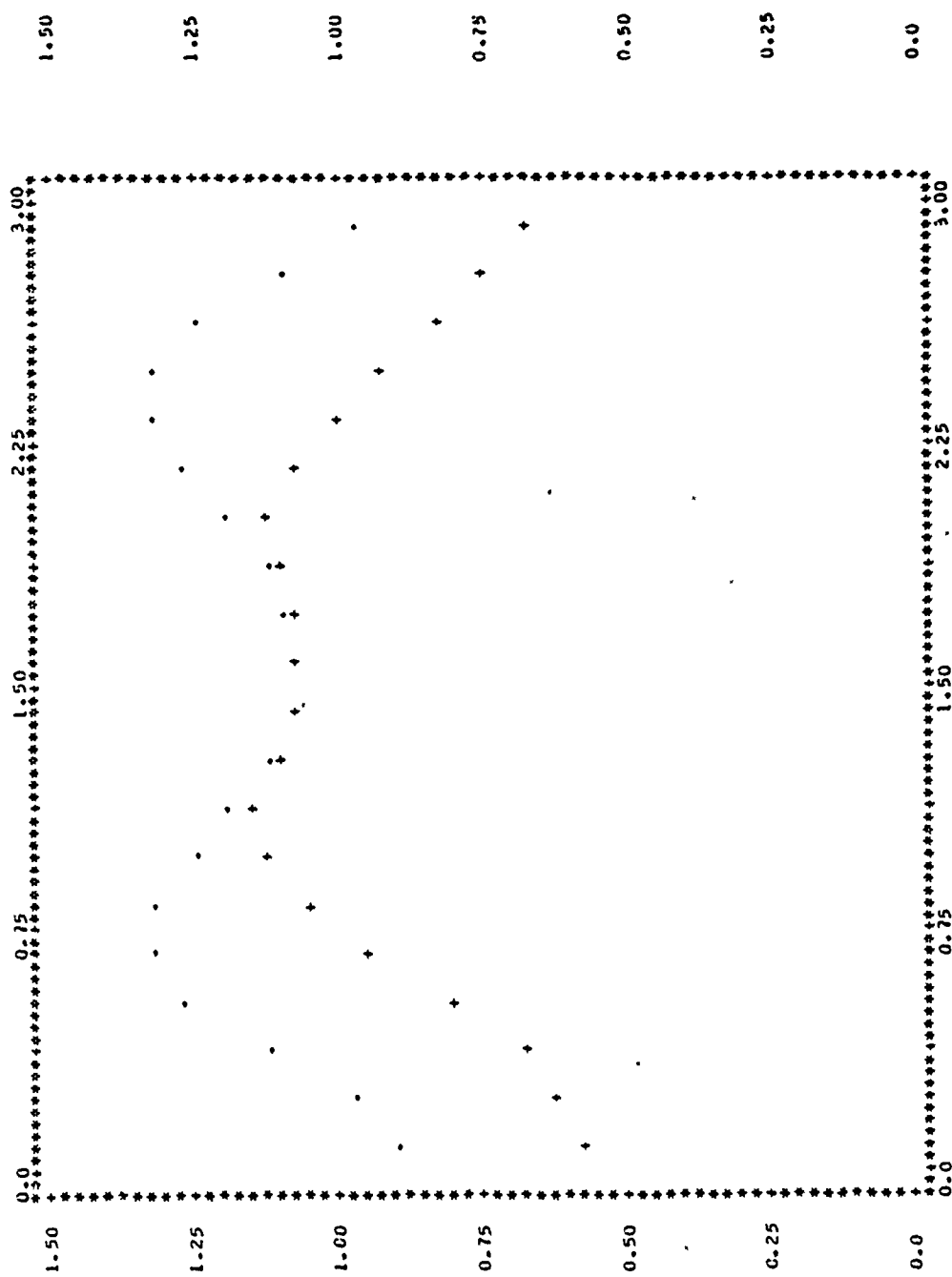
FIGURE 37. Continued.



FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0, $L/D = 4.57$
 VELOCITY PROFILE AT MIXING STACK END PLANE, $V/VAVG$ VS. X

.... A TRAVERSE
 +++ B TRAVERSE
 (c) $L/D = 4.57$

FIGURE 37. Continued.



FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0, $L/D = 3$
 VELOCITY PROFILE AT MIXING STACK END PLANE, $V/VAVG$ VS. X

... A TRAVERSE
 +++ B TRAVERSE

(d) $L/D = 3.0$

FIGURE 37. Continued.

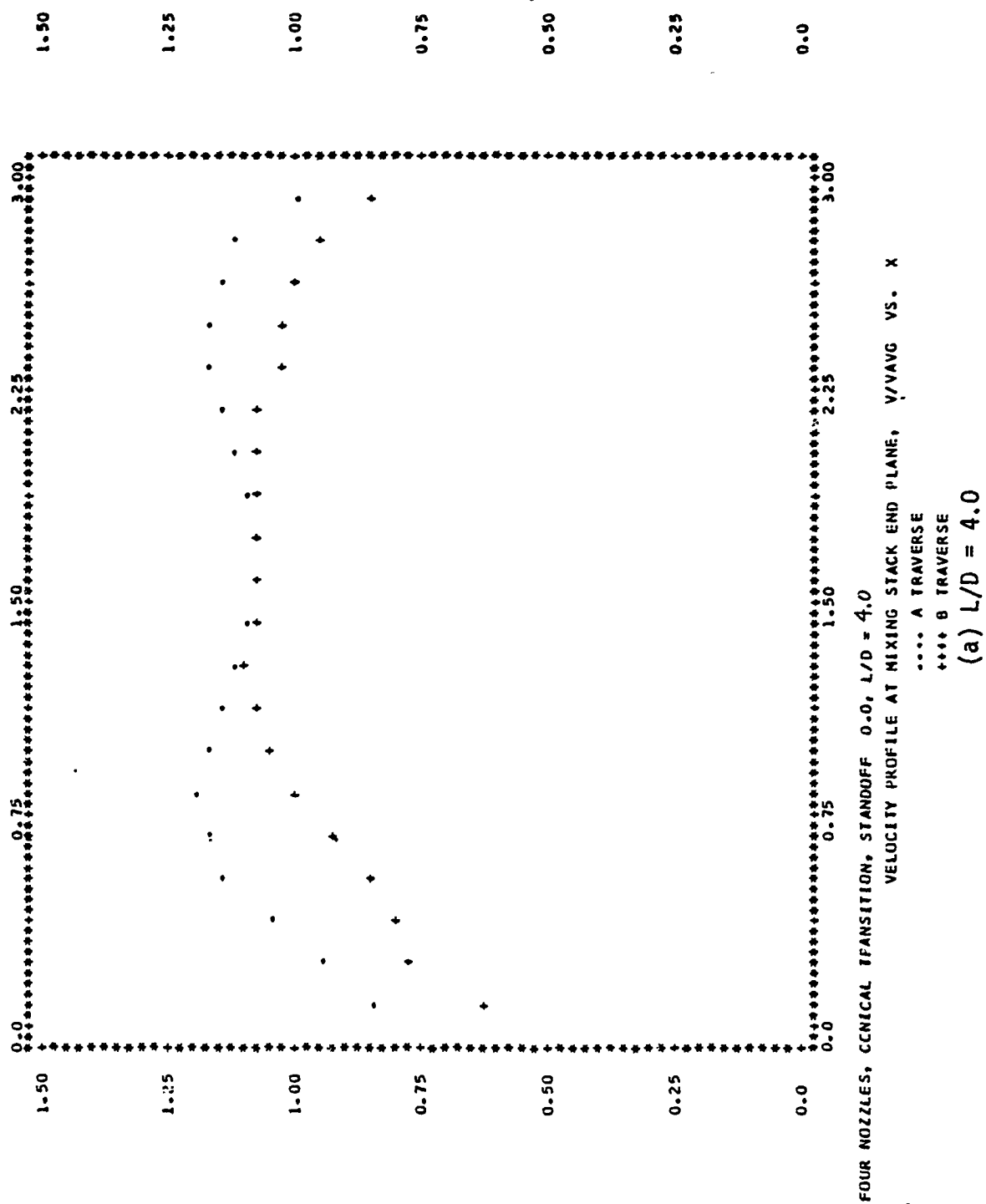
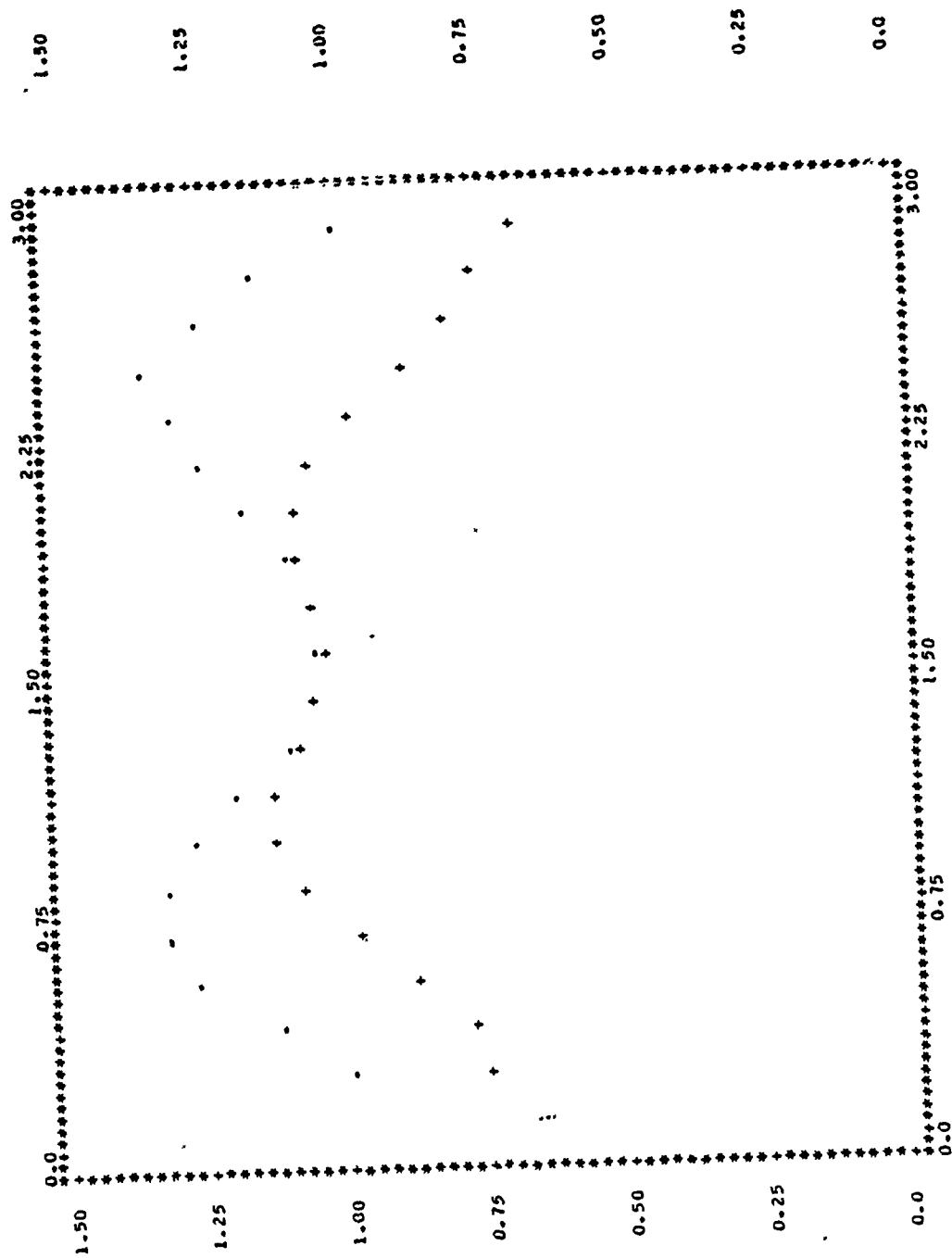


FIGURE 38. Mixing Stack Exit Velocity Profiles for Four Nozzles, Conical Transition, $M_u = 0.068$.



(b) L/D = 3.0
FIGURE 38. Continued.

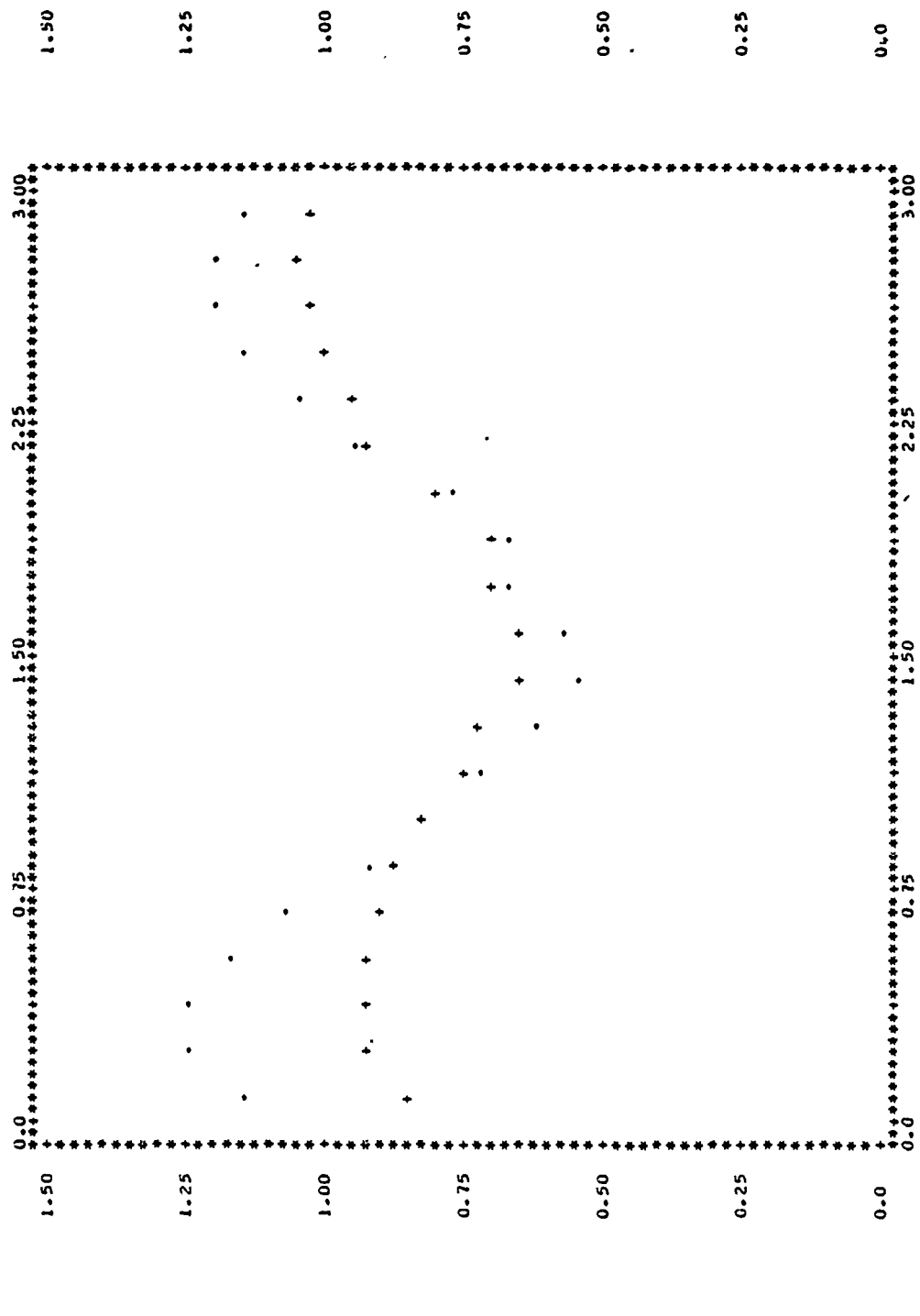


FIGURE 39. Mixing Stack Exit Velocity Profiles for Four Nozzles, Straight Entrance, $M_u = 0.068$.

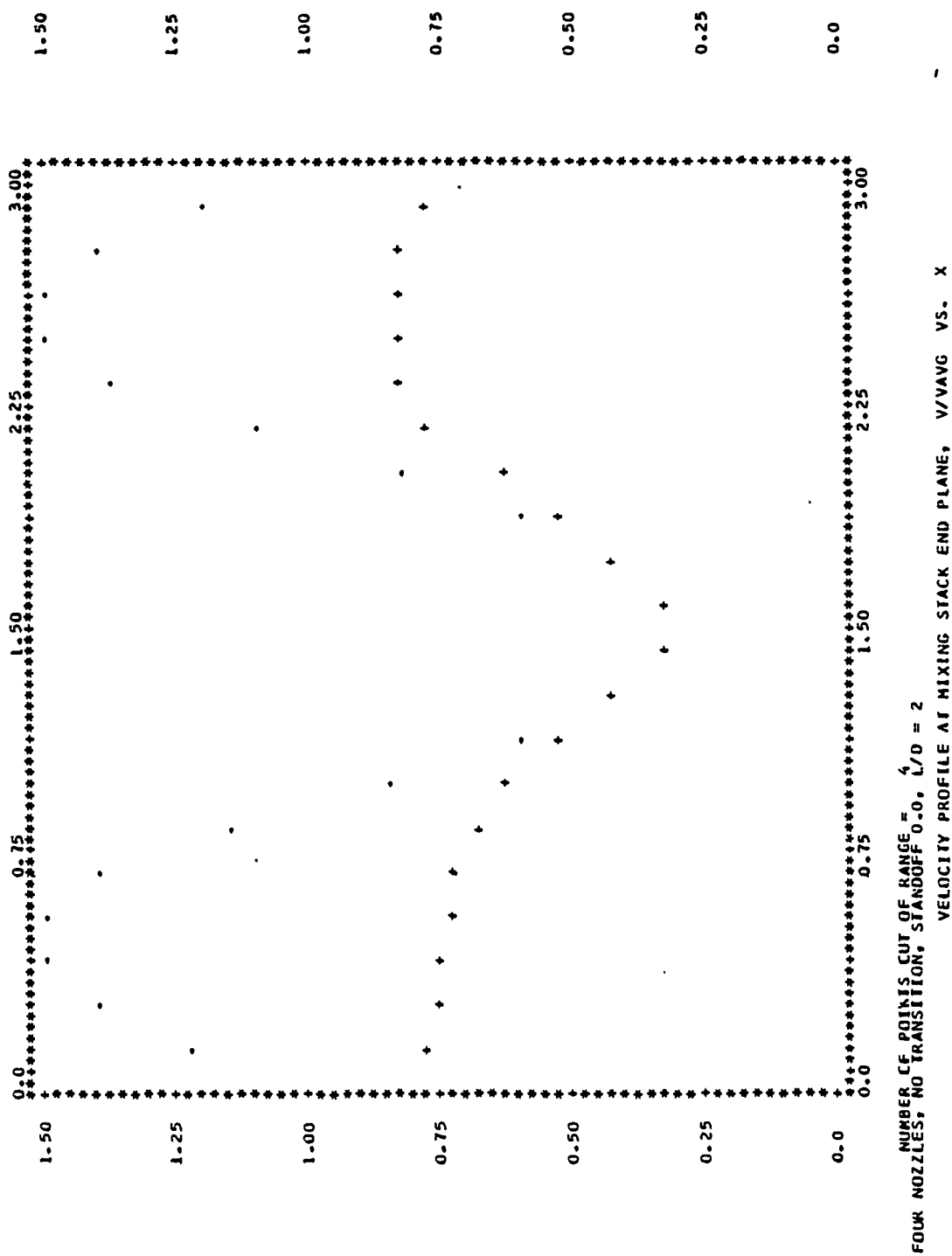


FIGURE 39. Continued.

IX. TABLES

SINGLE-NOZZLE CONFIGURATIONS

EACH CONFIGURATION TESTED AT 3 FLOW RATES; $M = 0.048$, $M = 0.068$, $M = 0.082$

S/D \ L/D		11.07	9.57	7.57	5.57	4.57	3.0	2.0
ELLIPTIC TRANSITION	-0.84	X	X	X	X	X		
	-0.24		X	X	X	X		
	0.0	X	X	X	X	X		
	1.00		X	X				
TRANSITION OFF	0.25						X	X
	0.50						X	X
	0.70						X	X
	1.00						X	X

Table I. Single-Nozzle Configurations Tested.

FOUR-NOZZLE CONFIGURATIONS
EACH CONFIGURATION TESTED AT NOMINAL FLOW RATE $M = 0.068$

S/D \ L/D		7.57	5.57	4.57	4.0	3.0	2.0
ELLIPTIC TRANSITION	-0.25	X	X	X		X	
	0.0	X	X	X		X	
	0.25	X	X	X		X	
	0.50	X					
CONICAL TRANSITION	-0.25				X	X	
	0.0				X	X	
	0.25				X	X	
TRANSITION OFF	0.0					X	X
	0.25					X	X
	0.50					X	X

Table II. Four-Nozzle Configurations Tested.

S/D \ L/D	11.07	9.57	7.57	5.57	4.57	3.0	2.0
ELLIPTIC TRANSITION							
-0.84	0.648	0.648	0.631	0.611	0.572		
-0.24		0.733	0.707	0.692	0.672		
0.0	0.720	0.728	0.720	0.698	0.691		
1.0	0.720	0.663	0.687				
STRAIGHT ENTRANCE							
0.25						0.569	0.472
0.50						0.613	0.534
0.75						0.612	0.606
1.0						0.615	0.560

ALL DATA FOR UPTAKE MACH NUMBER OF 0.068

Table III. Summary of Pumping Performance for Single-Nozzle Configurations, $W \cdot T^{*44}_{\max}$

<div>L/D S/D</div>	7.57	5.57	4.57	4.0	3.0	2.0
ELLIPTIC TRANSITION						
-0.25	0.735	0.770	0.760		0.730	
0.0	0.745	0.755	0.760		0.730	
0.25	0.710	0.740	0.740		0.740	
0.50	0.69					
CONICAL TRANSITION						
-0.25				0.740	0.720	
0.0				0.745	0.735	
0.25				0.740	0.735	
STRAIGHT ENTRANCE						
0.0					0.580	0.520
0.25					0.690	0.660
0.50					0.700	0.690

ALL DATA FOR UPTAKE MACH NUMBER OF 0.068

Table IV. Summary of Pumping Performance for Four-Nozzle Configurations, $W \cdot T^{.44}_{\max}$.

K_M

STACK ENTRANCE \ L/D	7.57	5.57	4.57	4.0	3.0	2.0
ELLIPTIC TRANSITION	1.005	1.006	1.010		1.038	
CONICAL TRANSITION				1.018	1.036	
STRAIGHT ENTRANCE					1.022	1.083

Table V. Mixing Performance for Four-Nozzle Configurations, K_m .

V_{MAX}/V_{AVG}									
L/D	9.07	8.07	6.07	5.07	4.07	3.07	4.0	3.0	2.0
ELLIPTIC TRANS. S/D = 0	1.17	1.20	1.37	1.48	1.62	1.77			
STRAIGHT ENTRANCE S/D=0.25							1.78	1.86	1.99

(a) Single-Nozzle Configurations

V_{MAX}/V_{AVG}						
STACK ENTRANCE L/D	7.57	5.57	4.57	4.0	3.0	2.0
ELLIPTIC TRANSITION	1.08	1.091	1.140		1.330	
CONICAL TRANSITION				1.180	1.330	
STRAIGHT ENTRANCE					1.140	1.570

(b) Four-Nozzle Configurations

Table VI. Mixing Performance, V_{max}/V_{avg} .

DATA TAKEN 17 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0 1/1/11.07/0/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 33.21 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 11.07

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.96 INCHES HG

N RUN	PUR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	WS (LBN/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	16.6	15.0	139.0	139.0	70.0	7.60	7.10	7.10	0.0	0.328	296.93	98.97	98.97	0.083
2	15.9	15.0	139.0	139.0	70.0	10.90	3.73	3.73	1.767	0.330	295.74	129.95	98.57	0.082
3	21.2	15.0	139.0	139.0	70.0	12.10	2.39	2.39	3.142	0.330	295.34	143.15	98.44	0.082
4	22.6	15.0	139.0	139.0	70.0	13.60	1.01	1.01	6.284	0.331	294.77	156.44	98.25	0.082
5	23.0	15.0	139.0	139.0	70.0	14.00	0.50	0.50	9.621	0.331	294.67	160.90	98.20	0.082
6	23.2	15.0	139.0	139.0	70.0	14.20	0.36	0.36	11.585	0.331	294.55	162.25	98.18	0.082
7	23.2	15.0	139.0	139.0	70.0	14.30	0.27	0.27	13.548	0.331	294.48	163.05	98.16	0.082
8	23.3	15.0	139.0	139.0	70.0	14.30	0.21	0.21	15.512	0.331	294.52	163.69	98.17	0.082
9	23.3	15.0	139.0	139.0	70.0	14.40	0.17	0.17	17.081	0.331	294.45	163.06	98.14	0.082
10	23.5	15.0	139.0	139.0	70.0	14.50	0.0	0.0	*****	0.331	294.45	*****	98.14	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0
 PHS(IN. H2O): 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 PMS*: 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

(a) S/D = 0.0, $M_u = 0.082$

Table VII. Single-Nozzle Performance Data for L/D = 11.07, Elliptic Transition

DATA TAKEN 17 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0 1/1/11.07/0/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 33.21 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 11.07

UPTAKE DIAMETER: 3.00 INCHES	AREA RATIO, AM/AP: 3.00	ORIFICE DIAMETER: 2.154 INCHES	ORIFICE BETA: 0.70	AMBIENT PRESSURE: 29.96 INCHES HG
UP	PA-PS	PA-PNZ	SECONDARY AREA	
(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)		
PU-PA	TAHB	TUPT	TOR	DPGR
(DEGREES FAHRENHEIT)				
1	11.1	10.0	137.0	137.0
2	13.3	10.0	137.0	137.0
3	14.1	10.0	137.0	137.0
4	15.0	10.0	137.0	137.0
5	15.4	10.0	137.0	137.0
6	15.5	10.0	137.0	137.0
7	15.5	10.0	137.0	137.0
8	15.5	10.0	137.0	137.0
9	15.6	10.0	137.0	137.0
10	15.6	10.0	137.0	137.0

WS	UP	UM	UU	UPT MACH
(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	
WP				
W/T**44	P*/T*	T*	P*	W*
1	0.877	0.3533	0.877	0.3533
2	0.877	0.1882	0.877	0.1882
3	0.877	0.1225	0.877	0.1225
4	0.877	0.0503	0.877	0.0503
5	0.877	0.0259	0.877	0.0259
6	0.877	0.0183	0.877	0.0183
7	0.877	0.0137	0.877	0.0137
8	0.877	0.0107	0.877	0.0107
9	0.877	0.0092	0.877	0.0092
10	0.877	0.0	0.877	0.0

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0
 PMS(IN. H2O): -6.25 -1.65 0.10 0.45 0.70 0.15 0.55 0.40
 PMS*: -0.48 -0.13 0.01 0.03 0.05 0.06 0.04 0.03

(b) S/D = 0.0, $M_u = 0.068$

Table VII. Continued.

DATA TAKEN 17 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0 1/1/11.07/0/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 33.21 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 11.07

N RUN	POR (INCHES CF WATER)	OPOR	YOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	5.5	5.0	138.0	138.0	72.0	2.50	2.33	2.33	0.0
2	6.6	5.0	138.0	138.0	72.0	3.60	1.22	1.22	1.767
3	7.2	5.0	138.0	138.0	72.0	4.10	0.77	0.77	3.142
4	7.6	5.0	137.0	137.0	72.0	4.60	0.32	0.32	6.284
5	7.8	5.0	137.0	137.0	72.0	4.70	0.16	0.16	9.621
6	7.8	5.0	137.0	137.0	72.0	4.80	0.12	0.12	11.585
7	7.8	5.0	140.0	140.0	72.0	4.80	0.09	0.09	13.548
8	7.8	5.0	137.0	137.0	72.0	4.80	0.07	0.07	15.512
9	7.8	5.0	137.0	137.0	72.0	4.80	0.06	0.06	17.081
10	7.9	5.0	137.0	137.0	72.0	4.90	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	WT**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3489	0.8896	0.3923	0.0	0.189	0.0	172.95	57.65	57.65	0.048
2	0.3505	0.1832	0.8896	0.2059	0.3329	0.189	0.066	172.72	75.51	57.57	0.048
3	0.4948	0.1157	0.8896	0.1301	0.4700	0.150	0.094	172.63	82.91	57.54	0.048
4	0.6322	0.0475	0.8911	0.0533	0.6009	0.190	0.120	172.36	89.95	57.45	0.048
5	0.6896	0.0241	0.8911	0.0271	0.6555	0.190	0.131	172.36	92.92	57.45	0.048
6	0.7040	0.0173	0.8911	0.0195	0.6692	0.190	0.134	172.32	93.65	57.44	0.048
7	0.7302	0.0135	0.8866	0.0152	0.6925	0.189	0.138	172.75	95.02	57.58	0.048
8	0.7354	0.0106	0.8911	0.0119	0.6990	0.150	0.140	172.32	95.27	57.44	0.048
9	0.7498	0.0091	0.8911	0.0102	0.7127	0.190	0.142	172.32	96.01	57.44	0.048
10	*****	0.0	0.8911	0.0	*****	0.190	*****	172.30	*****	57.43	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
PHS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PHS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(c) S/D = 0.0, $M_u = 0.048$

Table VII. Continued.

DATA TAKEN ON 20 MAY 77 BY PETE HARPELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84

1/1/11.07/-084/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 33.21 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 11.07

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.96 INCHES HG

N RUN	POR (INCHES OF WATER)	OPOR (INCHES OF WATER)	TOR	TUR (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UP (FT/SEC)	UU (FT/SEC)	UPT MACH
1	16.7	15.0	143.0	143.0	69.0	7.70	6.90	6.90	0.0	99.29	297.89	59.29	0.083
2	18.1	15.0	143.0	143.0	69.0	9.20	5.25	5.25	0.785	115.56	297.31	99.10	0.082
3	19.2	15.0	143.0	143.0	69.0	10.30	3.63	3.63	1.767	129.83	296.91	98.96	0.082
4	20.2	15.0	142.0	142.0	69.0	11.30	2.22	2.22	3.142	141.75	296.30	98.76	0.082
5	20.9	15.0	144.0	144.0	69.0	11.90	0.85	0.85	6.284	152.09	296.61	98.86	0.082
6	21.1	15.0	144.0	144.0	69.0	12.10	0.42	0.42	9.621	156.13	296.53	98.84	0.082
7	21.2	15.0	141.0	141.0	69.0	12.30	0.22	0.22	13.548	157.00	295.69	98.56	0.082
8	21.2	15.0	141.0	141.0	69.0	12.30	0.17	0.17	15.512	157.38	295.69	98.56	0.082
9	21.2	15.0	141.0	141.0	69.0	12.30	0.15	0.15	17.082	159.40	295.69	98.56	0.082
10	21.4	15.0	139.0	139.0	69.0	12.40	0.0	0.0	*****	*****	295.20	98.39	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
PMSTIN. H2O1:	*****	-4.50	-2.30	-0.95	-0.20	0.30	0.55	0.60
PMST:	-0.59	-0.23	-0.12	-0.05	-0.01	0.02	0.03	0.03

(d) S/D = -0.84, $M_u = 0.082$

Table VII. Continued.

DATA TAKEN ON 20 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84

1/1/11.07/-084/10

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 33.21 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 11.07

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.96 INCHES HG

N RUN	POR (INCHES OF WATER)	OPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PN2 (SQARE INCHES)	SECONDARY AREA (SQARE INCHES)
1	11.1	10.0	140.0	140.0	70.0	5.10	4.60	4.60	0.0
2	12.1	10.0	140.0	140.0	70.0	6.10	3.50	3.50	0.785
3	12.9	10.0	140.0	140.0	70.0	6.90	2.43	2.43	1.767
4	13.4	10.0	140.0	140.0	70.0	7.40	1.48	1.48	3.142
5	13.9	10.0	140.0	140.0	70.0	7.90	0.57	0.57	6.284
6	14.0	10.0	140.0	140.0	70.0	8.00	0.28	0.28	9.621
7	14.1	10.0	140.0	140.0	70.0	8.10	0.16	0.16	13.548
8	14.1	10.0	140.0	140.0	70.0	8.10	0.12	0.12	15.512
9	14.1	10.0	140.0	140.0	70.0	8.10	0.10	0.10	17.082
10	14.2	10.0	140.0	140.0	70.0	8.20	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*T**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3457	0.8833	0.3914	0.0	0.267	0.0	243.68	81.22	81.22	0.068
2	0.1870	0.2637	0.8833	0.2985	0.1771	0.268	0.050	243.38	94.57	81.12	0.068
3	0.3505	0.1834	0.8833	0.2077	0.3318	0.268	0.094	243.14	106.32	81.04	0.068
4	0.4860	0.1119	0.8833	0.1266	0.4602	0.268	0.130	243.00	116.11	80.99	0.067
5	0.6029	0.0431	0.8833	0.0488	0.5709	0.268	0.162	242.85	124.56	80.94	0.067
6	0.6469	0.0212	0.8833	0.0240	0.6125	0.268	0.174	242.82	127.75	80.93	0.067
7	0.6885	0.0121	0.8833	0.0137	0.6519	0.268	0.185	242.79	130.77	80.92	0.067
8	0.6827	0.0091	0.8833	0.0103	0.6464	0.268	0.183	242.79	130.35	80.92	0.067
9	0.6863	0.0076	0.8833	0.0086	0.6498	0.268	0.184	242.79	130.61	80.92	0.067
10	*****	0.0	0.8833	0.0	*****	0.268	*****	242.76	*****	80.91	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
PMS(IN. H2O):	-7.70	-2.75	-1.35	-0.30	0.05	0.30	0.45	0.45
PMS*:	-0.58	-0.21	-0.10	-0.02	0.00	0.02	0.03	0.03

(e) S/D = -0.84, $M_u = 0.068$

Table VII. Continued.

DATA TAKEN ON 20 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/11.07/-084/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 33.21 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 11.07

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.96 INCHES HG

N	POR	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA	UPT	UPT
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREE FAHRENHEIT)		(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)	(FT/SEC)	(FT/SEC)
1	5.6	5.0	135.0	135.0	71.0	2.60	2.30	2.30	0.0	57.49	57.49
2	6.1	5.0	135.0	135.0	71.0	3.10	1.74	1.74	0.785	57.46	57.46
3	6.4	5.0	135.0	135.0	71.0	3.40	1.18	1.18	1.767	57.44	57.44
4	6.8	5.0	136.0	136.0	71.0	3.80	0.71	0.71	3.142	57.46	57.46
5	7.0	5.0	136.0	136.0	71.0	4.00	0.27	0.27	6.284	57.44	57.44
6	7.1	5.0	136.0	136.0	71.0	4.10	0.13	0.13	9.621	57.44	57.44
7	7.1	5.0	136.0	136.0	71.0	4.10	0.07	0.07	13.546	57.44	57.44
8	7.1	5.0	136.0	136.0	71.0	4.10	0.05	0.05	15.512	57.44	57.44
9	7.1	5.0	136.0	136.0	71.0	4.10	0.05	0.05	17.062	57.44	57.44
10	7.2	5.0	136.0	136.0	71.0	4.20	0.0	0.0	*****	57.43	57.43

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0
 PMS(IN. H2O): -4.75 -1.20 -0.50 0.0 0.15 0.30 0.40 0.40
 PMS*: -0.72 -0.18 -0.08 0.0 0.02 0.05 0.06 0.06

(f) S/D = -0.84, $M_u = 0.048$

Table VII. Continued.

DATA TAKEN 30 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 1.00 1/1/9.57/100/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 28.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 9.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.87 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PHZ (INCHES OF WATER)	SECONDARY AREA (SQARE INCHES)
1	16.6	15.0	146.0	146.0	65.0	7.60	7.00	7.00	0.0
2	18.6	15.0	146.0	146.0	65.0	9.60	5.10	5.10	0.785
3	20.1	15.0	147.0	147.0	65.0	11.10	3.51	3.51	1.767
4	21.4	15.0	147.0	147.0	65.0	12.40	2.20	2.20	3.142
5	22.8	15.0	147.0	147.0	65.0	13.80	0.90	0.90	6.284
6	23.2	15.0	148.0	148.0	65.0	14.20	0.45	0.45	9.621
7	23.4	15.0	148.0	148.0	65.0	14.40	0.25	0.25	13.548
8	23.5	15.0	148.0	148.0	65.0	14.50	0.19	0.19	15.512
9	23.5	15.0	148.0	148.0	65.0	14.50	0.16	0.16	17.022
10	23.5	15.0	148.0	148.0	65.0	14.60	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*/T**	MP (LBN/SEC)	WS (LBN/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3469	0.8663	0.4005	0.0	0.326	0.0	299.14	99.71	95.71	0.083
2	0.1856	0.2540	0.8663	0.2932	0.1742	0.327	0.061	298.41	115.61	55.46	0.082
3	0.3462	0.1752	0.8648	0.2025	0.3248	0.327	0.113	298.10	129.58	99.36	0.082
4	0.4866	0.1101	0.8648	0.1273	0.4565	0.328	0.159	297.63	141.82	99.20	0.082
5	0.6198	0.0450	0.8648	0.0520	0.5814	0.328	0.203	297.12	153.47	99.04	0.082
6	0.6731	0.0226	0.8634	0.0262	0.6310	0.328	0.221	297.22	158.17	99.07	0.082
7	0.7063	0.0126	0.8634	0.0145	0.6621	0.328	0.232	297.15	161.10	55.04	0.082
8	0.7049	0.0095	0.8634	0.0111	0.6608	0.328	0.231	297.12	160.97	99.03	0.082
9	0.7123	0.0080	0.8634	0.0093	0.6678	0.328	0.234	297.12	161.63	99.03	0.082
10	*****	0.0	0.8634	0.0	*****	0.328	*****	297.04	*****	55.01	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	3.0	4.0	5.0	6.0	7.0	8.0
PMS (IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(a) S/D = 1.0, $M_u = 0.082$

Table VIII. Single-Nozzle Performance Data for L/D = 9.57, Elliptic Transition

DATA TAKEN 30 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 1.00 1/1/9.57/100/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 28.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 9.57

N RUN	POR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAB8	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	11.1	10.0	145.0	65.0	5.10	4.60	4.60	0.0
2	12.4	10.0	145.0	65.0	6.40	3.38	3.38	0.785
3	13.4	10.0	146.0	65.0	7.40	2.30	2.30	1.767
4	14.4	10.0	146.0	65.0	8.30	1.46	1.46	3.142
5	15.2	10.0	146.0	65.0	9.20	0.59	0.59	6.284
6	15.4	10.0	147.0	65.0	9.40	0.29	0.29	5.621
7	15.7	10.0	147.0	65.0	9.60	0.16	0.16	13.548
8	15.7	10.0	148.0	65.0	9.60	0.12	0.12	15.512
9	15.6	10.0	148.0	65.0	9.60	0.10	0.10	17.062
10	15.7	10.0	141.0	65.0	5.70	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W* T* .44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3396	0.8677	0.3914	0.0	0.266	0.0	245.09	81.65	81.65	0.068
2	0.1854	0.2503	0.8677	0.2885	0.1741	0.266	0.049	244.69	94.68	81.56	0.068
3	0.3441	0.1705	0.8663	0.1968	0.3230	0.266	0.092	244.60	105.95	81.53	0.068
4	0.4868	0.1084	0.8663	0.1252	0.4570	0.267	0.130	244.35	116.11	81.45	0.068
5	0.6158	0.0436	0.8663	0.0503	0.5781	0.267	0.164	244.06	125.29	81.35	0.067
6	0.6642	0.0216	0.8648	0.0249	0.6231	0.267	0.177	244.20	128.77	81.39	0.067
7	0.6944	0.0119	0.8648	0.0138	0.6515	0.267	0.185	244.17	130.95	81.38	0.067
8	0.6892	0.0089	0.8634	0.0103	0.6460	0.267	0.184	244.37	130.58	81.45	0.067
9	0.6929	0.0074	0.8634	0.0086	0.6495	0.267	0.185	244.34	130.83	81.44	0.067
10	*****	0.0	0.8735	0.0	*****	0.268	*****	242.90	*****	80.96	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	3.0	4.0	5.0	6.0	7.0	8.0
PMS(IN. H2O):	-0.72	-0.51	0.12	0.22	0.14	0.09	0.06	0.34
PMS*:	-0.05	-0.04	0.01	0.02	0.01	0.01	0.00	0.03

(b) S/D = 1.0, $M_u = 0.068$

Table VIII. Continued.

DATA TAKEN 30 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 1.00 1/1/9.57/100/05

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 28.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 9.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.7C

AMBIENT PRESSURE: 29.87 INCHES HG

N RUN	POR (INCHES OF WATER)	TDR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UP (FT/SEC)	WS (LBM/SEC)	WP (LBM/SEC)	M* W* T* P* T*	P*/T*	M* W* T* P* T*	UW (FT/SEC)	UU (FT/SEC)	UPT MACH
1	5.6	5.0	141.0	141.0	67.0	2.60	2.24	2.24	0.0	0.0	0.0	0.188	0.0	0.3772	0.0	173.64	57.88	0.048
2	6.3	5.0	141.0	141.0	67.0	3.20	1.66	1.66	0.785	0.0	0.0	0.189	0.035	0.2799	0.1728	173.52	57.84	0.048
3	6.7	5.0	141.0	141.0	67.0	3.70	1.11	1.11	1.767	0.0	0.0	0.189	0.064	0.1874	0.3170	173.40	57.80	0.048
4	7.1	5.0	141.0	141.0	67.0	4.10	0.68	0.68	3.142	0.0	0.0	0.189	0.088	0.1149	0.4421	173.32	57.77	0.048
5	7.7	5.0	141.0	141.0	67.0	4.60	0.28	0.28	6.284	0.0	0.0	0.189	0.113	0.0465	0.5619	173.23	57.74	0.048
6	7.9	5.0	142.0	142.0	67.0	4.80	0.14	0.14	9.621	0.0	0.0	0.189	0.121	0.0229	0.6027	173.33	57.77	0.048
7	7.9	5.0	142.0	142.0	67.0	4.80	0.07	0.07	13.548	0.0	0.0	0.189	0.122	0.0118	0.6111	173.33	57.77	0.048
8	7.9	5.0	143.0	143.0	67.0	4.80	0.05	0.05	15.512	0.0	0.0	0.189	0.124	0.0093	0.6203	173.48	57.82	0.048
9	7.9	5.0	143.0	143.0	67.0	4.90	0.04	0.04	17.082	0.0	0.0	0.189	0.124	0.0076	0.6178	173.44	57.81	0.048
10	8.0	5.0	143.0	143.0	67.0	4.90	0.0	0.0	*****	0.0	0.0	0.189	*****	0.0	*****	173.46	57.82	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	3.0	4.0	5.0	6.0	7.0	8.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(c) S/D = 1.0, $M_u = 0.048$

Table VIII. Continued.

DATA TAKEN 27 MAY 77 BY PETE HARRELL

ONE NOZZLE. ELLIPTIC TRANSITION, STANDOFF 0.0

1/1/9-57/0/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 28.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 9.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.87 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	16.6	15.0	147.0	147.0	64.0	7.60	7.10	7.10	0.0
2	18.3	15.0	147.0	147.0	64.0	9.30	5.32	5.32	0.785
3	19.8	15.0	148.0	148.0	64.0	10.80	3.76	3.76	1.767
4	21.2	15.0	148.0	148.0	64.0	12.20	2.44	2.44	3.142
5	22.4	15.0	149.0	149.0	64.0	13.40	1.00	1.00	6.264
6	23.0	15.0	150.0	150.0	64.0	14.00	0.50	0.50	9.621
7	23.2	15.0	150.0	150.0	64.0	14.20	0.27	0.27	13.543
8	23.2	15.0	152.0	152.0	64.0	14.20	0.21	0.21	15.512
9	23.2	15.0	152.0	152.0	64.0	14.20	0.17	0.17	17.082
10	23.4	15.0	152.0	152.0	64.0	14.40	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W* T* .44	WP (LBH/SEC)	WS (LBH/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3506	0.8632	0.4062	0.0	0.326	0.0	299.39	99.79	99.79	0.083
2	0.1899	0.2638	0.8632	0.3056	0.1780	0.326	0.062	298.76	116.04	99.58	0.082
3	0.3591	0.1868	0.8618	0.2168	0.3363	0.327	0.117	298.46	130.70	99.48	0.082
4	0.5135	0.1217	0.8618	0.1412	0.4810	0.327	0.168	297.95	144.12	99.31	0.082
5	0.6571	0.0499	0.8604	0.0580	0.6151	0.327	0.215	297.76	156.69	99.25	0.082
6	0.7115	0.0250	0.8589	0.0291	0.6655	0.327	0.233	297.78	161.46	99.26	0.082
7	0.7361	0.0135	0.8589	0.0157	0.6884	0.327	0.241	297.71	163.61	99.23	0.082
8	0.7445	0.0105	0.8561	0.0122	0.6953	0.327	0.243	298.20	164.37	99.39	0.082
9	0.7376	0.0085	0.8561	0.0099	0.6889	0.327	0.241	298.20	163.77	99.39	0.082
10	*****	0.0	0.8561	0.0	*****	0.327	*****	298.13	*****	99.37	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	3.0	4.0	5.0	6.0	7.0	8.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(d) S/D = 0.0, $M_u = 0.082$

Table VIII. Continued.

DATA TAKEN 27 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0

1/1/9.57/0/10

NUMBER OF PRIMARY NOZZLES: 1
 UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 25.86 INCHES HG

PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 28.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 9.57

N RUN	POR (INCHES OF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	11.0	10.0	143.0	143.0	70.0	5.00	4.68	4.68	0.0	81.57	81.57	0.068
2	12.2	10.0	143.0	143.0	70.0	6.20	3.55	3.55	0.785	81.45	81.45	0.068
3	13.2	10.0	143.0	143.0	70.0	7.20	2.48	2.48	1.767	81.35	81.35	0.068
4	14.1	10.0	143.0	143.0	70.0	8.10	1.60	1.60	3.142	81.26	81.26	0.067
5	15.0	10.0	143.0	143.0	70.0	9.00	0.68	0.68	6.284	81.18	81.18	0.067
6	15.4	10.0	143.0	143.0	70.0	9.30	0.34	0.34	9.621	81.16	81.16	0.067
7	15.5	10.0	143.0	143.0	70.0	9.50	0.19	0.19	13.548	81.14	81.14	0.067
8	15.6	10.0	143.0	143.0	70.0	9.50	0.15	0.15	15.512	81.14	81.14	0.067
9	15.6	10.0	143.0	143.0	70.0	9.50	0.12	0.12	17.082	81.12	81.12	0.067
10	15.6	10.0	143.0	143.0	70.0	9.60	0.0	0.0	*****	81.12	81.12	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 0.5 3.0 4.0 5.0 6.0 7.0 8.0
 PMS (IN. H2O): -1.34 -1.20 -0.21 0.0 0.01 0.01 0.03 0.03
 PMS*: -0.10 -0.09 -0.02 0.0 0.00 0.00 0.00 0.00
 (e) S/D = 0.0, $M_u = 0.068$

Table VIII. Continued.

DATA TAKEN 27 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0 1/1/9.57/0/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 28.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 9.57

N	POR	DPOR	TOP	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)
1	5.6	5.0	142.0	142.0	70.0	2.60	2.37	2.37	0.0
2	6.2	5.0	142.0	142.0	70.0	3.20	1.77	1.77	0.785
3	6.6	5.0	142.0	142.0	70.0	3.60	1.26	1.26	1.767
4	7.0	5.0	142.0	142.0	70.0	4.00	0.77	0.77	3.142
5	7.6	5.0	143.0	143.0	70.0	4.60	0.33	0.33	6.284
6	7.7	5.0	143.0	143.0	70.0	4.70	0.16	0.16	9.621
7	7.7	5.0	143.0	143.0	70.0	4.80	0.09	0.09	13.548
8	7.7	5.0	143.0	143.0	70.0	4.80	0.07	0.07	15.512
9	7.9	5.0	143.0	143.0	70.0	4.80	0.06	0.06	17.082
10	8.0	5.0	141.0	141.0	70.0	4.90	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UM	UU	UPT
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	MACH
1	0.0	0.3513	0.8803	0.3991	0.0	0.188	0.0	173.80	57.93	57.93	0.048
2	0.1886	0.2628	0.9803	0.2985	0.1784	0.188	0.036	173.67	67.45	57.89	0.048
3	0.3581	0.1872	0.8803	0.2127	0.3386	0.189	0.068	173.59	76.05	57.86	0.048
4	0.4975	0.1145	0.9803	0.1301	0.4704	0.189	0.094	173.50	83.15	57.83	0.048
5	0.6465	0.0483	0.8789	0.0550	0.6108	0.189	0.122	173.52	90.77	57.84	0.048
6	0.6944	0.0238	0.8789	0.0271	0.6561	0.189	0.131	173.50	93.22	57.83	0.048
7	0.7211	0.0129	0.8789	0.0147	0.6813	0.189	0.136	173.46	94.57	57.82	0.048
8	0.7406	0.0104	0.8789	0.0119	0.6997	0.189	0.140	173.46	95.57	57.82	0.048
9	0.7549	0.0089	0.8789	0.0102	0.7132	0.189	0.142	173.50	96.32	57.83	0.048
10	*****	0.0	0.8818	0.0	*****	0.189	*****	173.19	*****	57.73	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	3.0	4.0	5.0	6.0	7.0	8.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(f) S/D = 0.0, $M_u = 0.048$

Table VIII. Continued.

DATA TAKEN 27 MAY 77 BY PETE HARRELL

ONE NOZZLE. ELLIPTIC TRANSITION. STANDOFF -0.24

1/1/9-57/-024/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 28.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 9.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AN/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.86 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR	TUFT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UH (FT/SEC)	UU (FT/SEC)	UPT MACH
1	16.6	15.0	149.0	149.0	69.0	7.60	7.00	7.00	0.0	99.97	99.97	0.083
2	18.3	15.0	149.0	149.0	69.0	9.30	5.35	5.35	0.785	99.76	99.76	0.082
3	19.7	15.0	146.0	146.0	69.0	10.70	3.80	3.80	1.767	99.34	99.34	0.082
4	21.0	15.0	146.0	146.0	69.0	12.00	2.46	2.46	3.142	95.18	95.18	0.082
5	22.3	15.0	146.0	146.0	69.0	13.30	1.03	1.03	6.284	99.03	99.03	0.082
6	22.8	15.0	146.0	146.0	69.0	13.80	0.51	0.51	9.421	98.96	98.96	0.082
7	22.9	15.0	146.0	146.0	69.0	13.90	0.28	0.28	13.548	98.93	98.93	0.082
8	22.9	15.0	146.0	146.0	69.0	14.00	0.22	0.22	15.512	98.93	98.93	0.082
9	22.9	15.0	146.0	146.0	69.0	14.00	0.18	0.18	17.082	98.93	98.93	0.082
10	23.2	15.0	146.0	146.0	69.0	14.20	0.0	0.0	*****	98.92	98.92	0.082

135

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/O:	0.0	0.5	3.0	4.0	5.0	6.0	7.0	8.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(g) S/D = -0.24, $M_u = 0.082$

Table VIII. Continued.

DATA TAKEN 27 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24 1/1/9.57/-024/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 28.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 9.57

N	POR	UPDR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PH2	SECONDARY AREA
RUN	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)
1	11.1	10.0	139.0	139.0	70.0	5.10	4.64	4.64	0.0
2	12.2	10.0	139.0	139.0	70.0	6.20	3.55	3.55	0.785
3	13.1	10.0	139.0	139.0	70.0	7.10	2.52	2.52	1.767
4	13.9	10.0	140.0	140.0	70.0	7.90	1.64	1.64	3.142
5	14.8	10.0	137.0	137.0	70.0	8.80	0.68	0.68	6.284
6	15.1	10.0	140.0	140.0	70.0	9.00	0.40	0.40	9.421
7	15.2	10.0	140.0	140.0	70.0	9.10	0.19	0.19	12.548
8	15.3	10.0	140.0	140.0	70.0	9.20	0.15	0.15	15.212
9	15.3	10.0	140.0	140.0	70.0	9.20	0.13	0.13	17.882
10	15.5	10.0	146.0	146.0	70.0	9.40	0.0	0.0	*****

N	W*	P*	T*	P*/T*	WAT**44	WP	WS	UP	UM	UC	UNIT MACH
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	
1	0.0	0.3493	0.8847	0.3948	0.0	0.267	0.0	243.90	81.29	81.29	0.068
2	0.1882	0.2680	0.8847	0.3029	0.1783	0.268	0.050	243.56	96.76	81.18	0.068
3	0.3565	0.1906	0.8847	0.2155	0.3378	0.268	0.095	243.30	106.89	81.09	0.068
4	0.5113	0.1241	0.8833	0.1405	0.4841	0.268	0.137	243.26	118.12	81.08	0.068
5	0.6561	0.0518	0.8877	0.0584	0.6226	0.269	0.176	242.38	128.57	80.79	0.067
6	0.7721	0.0303	0.8833	0.0344	0.7311	0.268	0.207	242.96	137.08	80.98	0.067
7	0.7493	0.0144	0.8833	0.0163	0.7094	0.268	0.201	242.93	135.42	80.57	0.067
8	0.7621	0.0114	0.8833	0.0129	0.7216	0.268	0.205	242.90	136.35	80.96	0.067
9	0.7813	0.0099	0.8833	0.0112	0.7398	0.268	0.210	242.90	137.75	80.96	0.067
10	*****	0.0	0.8745	0.0	*****	0.767	*****	244.05	*****	81.35	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	3.0	4.0	5.0	6.0	7.0	8.0
PHS(IN. H2O):	-1.46	-1.30	-0.37	-0.12	-0.07	-0.04	0.00	0.01
PHS%:	-0.11	-0.10	-0.03	-0.01	-0.00	-0.00	0.00	0.00

(h) S/D = -0.24, $M_u = 0.068$

Table VIII. Continued.

DATA TAKEN 27 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24 1/19.57/-024/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 28.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 9.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 25.86 INCHES HG

N	POR	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)	(INCHES OF WATER)	(SQARE INCHES)	
1	5.6	5.0	135.0	135.0	72.0	2.60	2.34	2.34	0.0
2	6.1	5.0	135.0	135.0	72.0	3.10	1.80	1.80	0.785
3	6.6	5.0	135.0	135.0	72.0	3.60	1.27	1.27	1.767
4	7.0	5.0	135.0	135.0	72.0	4.00	0.79	0.79	3.142
5	7.5	5.0	135.0	135.0	72.0	4.50	0.32	0.32	6.284
6	7.7	5.0	135.0	135.0	72.0	4.70	0.16	0.16	9.621
7	7.7	5.0	136.0	136.0	72.0	4.70	0.09	0.09	13.548
8	7.7	5.0	136.0	136.0	72.0	4.70	0.07	0.07	15.512
9	7.7	5.0	137.0	137.0	72.0	4.70	0.05	0.05	17.082
10	7.8	5.0	144.0	144.0	72.0	4.80	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UN	UU	UPT
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	MACH
1	0.0	0.3523	0.8941	0.3940	0.0	0.189	0.0	172.79	57.59	57.59	0.048
2	0.1888	0.2713	0.8941	0.3035	0.1797	0.190	0.036	172.68	67.25	57.56	0.048
3	0.3567	0.1917	0.8941	0.2144	0.3396	0.190	0.068	172.58	75.87	57.52	0.048
4	0.5001	0.1193	0.8941	0.1335	0.4760	0.190	0.095	172.49	83.26	57.49	0.048
5	0.6381	0.0487	0.8941	0.0545	0.6074	0.190	0.121	172.39	90.38	57.46	0.048
6	0.6885	0.0242	0.8941	0.0271	0.6554	0.190	0.131	172.34	92.95	57.44	0.048
7	0.7155	0.0131	0.8924	0.0147	0.6806	0.150	0.136	172.49	94.40	57.49	0.048
8	0.7243	0.0103	0.8926	0.0115	0.6890	0.190	0.137	172.49	94.85	57.49	0.048
9	0.7179	0.0083	0.8911	0.0093	0.6824	0.190	0.136	172.63	94.53	57.54	0.048
10	*****	0.0	0.8807	0.0	*****	0.189	*****	173.62	*****	57.87	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	3.0	4.0	5.0	7.0	8.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(i) S/D = -0.24, $M_u = 0.048$

Table VIII. Continued.

DATA TAKEN 27 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/9.57/-084/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 28.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 9.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.86 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UU (FT/SEC)	UM (FT/SEC)	UP (FT/SEC)	WS (LBM/SEC)	WP (LBM/SEC)	W* P*/T*	T* W*T**44	N	W*	P*	T*	UPT MACH
1	16.7	15.0	146.0	146.0	71.0	7.70	6.90	6.90	0.0												
2	18.1	15.0	146.0	146.0	71.0	9.10	5.30	5.30	0.785												
3	19.2	15.0	146.0	146.0	71.0	10.30	3.66	3.66	1.767												
4	20.1	15.0	146.0	146.0	71.0	11.10	2.22	2.22	3.142												
5	20.9	15.0	146.0	146.0	71.0	11.80	0.85	0.85	6.284												
6	21.0	15.0	146.0	146.0	71.0	12.00	0.41	0.41	9.621												
7	21.1	15.0	145.0	145.0	71.0	12.10	0.22	0.22	13.548												
8	21.2	15.0	145.0	145.0	71.0	12.10	0.17	0.17	15.512												
9	21.2	15.0	145.0	145.0	71.0	12.10	0.14	0.14	17.082												
10	21.3	15.0	147.0	147.0	71.0	12.20	0.0	0.0	*****												
1	0.0	0.3459	0.8762	0.3948	0.0	0.326	0.0	299.14	99.71	99.71	99.71	5.083									
2	0.1882	0.2666	0.8762	0.3043	0.1776	0.327	0.061	298.62	116.13	99.54	0.083										
3	0.3516	0.1847	0.8762	0.2108	0.3317	0.327	0.115	298.15	130.48	99.38	0.082										
4	0.4864	0.1122	0.8762	0.1281	0.4589	0.327	0.159	297.89	142.42	99.29	0.082										
5	0.6014	0.0430	0.8762	0.0491	0.5674	0.328	0.197	297.67	152.63	99.22	0.082										
6	0.6394	0.0208	0.8762	0.0237	0.6033	0.328	0.210	297.56	156.00	99.18	0.082										
7	0.6589	0.0112	0.8776	0.0127	0.6222	0.328	0.216	297.28	157.71	99.09	0.082										
8	0.6631	0.0086	0.8776	0.0098	0.6261	0.328	0.218	297.32	158.10	99.10	0.082										
9	0.6627	0.0071	0.8776	0.0081	0.6257	0.328	0.217	297.32	158.07	99.10	0.082										
0	*****	0.0	0.8747	C.0	*****	0.327	*****	297.77	*****	99.25	0.082										

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 0.5 3.0 4.0 5.0 6.0 7.0 8.0
 PMS(IN. H2O): -2.51 -2.15 -1.06 -0.55 -0.36 -0.25 -0.09 0.0
 PMS*: -0.13 -0.11 -0.05 -0.03 -0.02 -0.01 -0.00 0.0

(j) S/D = -0.84, $M_u = 0.082$

Table VIII. Continued.

DATA TAKEN 26 MAY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/9-57/-084/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 28.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 9.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 25.78 INCHES HG

N RUN	FOR (INCHES OF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	5.6	5.0	145.0	145.0	72.0	2.50	2.27	2.27	0.0
2	6.1	5.0	145.0	145.0	72.0	3.10	1.74	1.74	0.785
3	6.4	5.0	145.0	145.0	72.0	3.40	1.19	1.19	1.767
4	6.8	5.0	145.0	145.0	72.0	3.70	0.71	0.71	3.142
5	7.0	5.0	145.0	145.0	72.0	3.90	0.27	0.27	6.284
6	7.1	5.0	145.0	145.0	72.0	4.00	0.13	0.13	9.621
7	7.1	5.0	145.0	145.0	72.0	4.00	0.07	0.07	13.548
8	7.1	5.0	145.0	145.0	72.0	4.00	0.05	0.05	15.512
9	7.1	5.0	145.0	145.0	72.0	4.00	0.04	0.04	17.082
10	7.1	5.0	145.0	145.0	72.0	4.10	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*T**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3359	0.8793	3.3821	0.0	0.188	0.0	174.51	58.17	58.17	0.048
2	0.1872	0.2579	0.8793	0.2934	0.1769	0.188	0.035	174.36	67.62	58.12	0.048
3	0.3483	0.1765	0.8793	0.2008	0.3291	0.188	0.065	174.29	75.82	58.09	0.048
4	0.4765	0.1046	0.8793	0.1190	0.4502	0.188	0.090	174.25	82.38	58.08	0.048
5	0.5841	0.0394	0.8793	0.3448	0.5519	0.188	0.110	174.21	87.88	58.06	0.048
6	0.6214	0.0190	0.8793	0.0216	0.5872	0.188	0.117	174.18	89.79	58.06	0.048
7	0.6331	0.0100	0.8793	0.0113	0.5983	0.188	0.119	174.18	90.39	58.06	0.048
8	0.6262	0.0074	0.8793	0.0084	0.5917	0.188	0.118	174.18	90.04	58.06	0.048
9	0.6395	0.0064	0.8793	0.3073	0.6043	0.188	0.120	174.18	90.72	58.06	0.048
10	*****	0.0	0.8793	0.0	*****	0.188	*****	174.14	*****	58.04	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 3.0 0.5 3.0 4.0 5.0 6.0 7.0 8.0
 PMS(IN. H2O): -0.80 -0.68 -0.29 -0.14 -0.08 -0.04 0.03 0.00
 PMS*: -0.12 -0.10 -0.04 -0.02 -0.01 -0.01 0.00 0.00

(1) S/D = -0.84, $M_u = 0.048$

Table VIII. Continued.

DATA TAKEN 31 MAY 84 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 1.00

1/1/7.57/100/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 22.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AH/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.84 INCHES HG

N	POR	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA		
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)		
1	16.5	15.0	155.0	155.0	71.0	7.50	7.10	7.10	0.0		
2	18.3	15.0	155.0	155.0	71.0	9.40	5.18	5.18	0.785		
3	20.1	15.0	155.0	155.0	71.0	11.20	3.60	3.60	1.767		
4	21.4	15.0	155.0	155.0	71.0	12.40	2.21	2.21	3.142		
5	22.8	15.0	155.0	155.0	71.0	13.80	0.92	0.92	6.284		
6	22.2	15.0	155.0	155.0	71.0	14.20	0.45	0.45	9.621		
7	22.4	15.0	155.0	155.0	71.0	14.40	0.24	0.24	13.548		
8	22.4	15.0	152.0	152.0	71.0	14.50	0.19	0.19	15.512		
9	22.4	15.0	152.0	152.0	71.0	14.50	0.16	0.16	17.082		
10	23.5	15.0	148.0	148.0	71.0	14.60	0.0	0.0	*****		
N	W*	P*	T*	P*/T*	W*/T**44	WP	WS	UP	UM	UC	UPT MACH
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	
1	0.0	0.3506	0.8633	0.4061	0.0	0.323	0.0	301.54	100.51	100.51	0.083
2	0.1874	0.2570	0.8633	0.2977	0.1757	0.324	0.061	300.80	116.62	100.26	0.083
3	0.3509	0.1794	0.8633	0.2078	0.3290	0.325	0.114	300.14	130.83	100.04	0.082
4	0.4882	0.1104	0.8633	0.1279	0.4576	0.325	0.159	299.74	142.87	95.91	0.082
5	0.6289	0.0461	0.8633	0.0534	0.5895	0.326	0.205	299.22	155.25	99.74	0.082
6	0.6739	0.0226	0.8633	0.0262	0.6317	0.326	0.219	298.73	159.04	99.57	0.082
7	0.6928	0.0121	0.8633	0.0140	0.6495	0.326	0.226	298.66	160.72	95.55	0.082
8	0.7041	0.0096	0.8676	0.0111	0.6614	0.326	0.230	297.86	161.64	99.28	0.082
9	0.7115	0.0081	0.8676	0.0093	0.6684	0.326	0.232	297.86	162.30	99.28	0.082
10	*****	0.0	0.8733	0.0	*****	0.328	*****	297.19	*****	95.06	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	C.C
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(a) S/D = 1.0, $M_u = 0.082$

Table IX. Single-Nozzle Performance Data for L/D = 7.57, Elliptic Transition.

DATA TAKEN 31 MAY BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 1.00 1/1/7.57/100/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 2.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.84 INCHES HG

N RUN	POR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	11.1	149.0	149.0	70.0	5.00	4.70	4.70	0.0
2	12.3	149.0	149.0	70.0	6.30	3.43	3.43	0.785
3	13.4	150.0	150.0	70.0	7.40	2.37	2.37	1.767
4	14.3	151.0	151.0	70.0	8.25	1.49	1.49	3.142
5	15.1	152.0	152.0	70.0	9.10	0.61	0.61	6.284
6	15.5	153.0	153.0	70.0	9.50	0.31	0.31	9.621
7	15.6	154.0	154.0	70.0	9.60	0.17	0.17	13.548
8	15.7	154.0	154.0	70.0	9.60	0.13	0.13	15.512
9	15.7	151.0	151.0	70.0	9.60	0.10	0.10	17.062
10	15.7	147.0	147.0	70.0	9.70	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	WAT**44	WP (LBH/SEC)	WS (LBH/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT PACH
1	0.0	0.3478	0.8702	0.3997	0.0	0.265	0.0	246.08	82.02	82.02	0.068
2	0.1865	0.2547	0.8702	0.2927	0.1754	0.265	0.049	245.66	95.18	81.88	0.068
3	0.3487	0.1762	0.8688	0.2028	0.3278	0.265	0.093	245.52	106.78	81.84	0.068
4	0.4916	0.1108	0.8674	0.1277	0.4617	0.265	0.131	245.48	117.03	81.82	0.068
5	0.6290	0.0454	0.8659	0.0524	0.5904	0.265	0.167	245.42	126.91	81.80	0.067
6	0.6811	0.0227	0.8645	0.0262	0.6389	0.265	0.181	245.50	130.67	81.83	0.067
7	0.7060	0.0123	0.8631	0.0142	0.6617	0.265	0.187	245.67	132.47	81.88	0.067
8	0.7174	0.0097	0.8631	0.0112	0.6724	0.265	0.190	245.70	133.30	81.89	0.067
9	0.6912	0.0075	0.8674	0.0086	0.6492	0.266	0.184	245.09	131.38	81.65	0.067
10	*****	0.0	0.8731	0.0	*****	0.267	*****	244.23	*****	81.41	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS(IN. H2O):	-0.81	-0.60	0.01	0.07	0.04	0.09	0.07	0.10	0.04	0.02
PMS*:	-0.06	-0.05	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00

(b) S/D = 1.0, $M_u = 0.068$

Table IX. Continued.

DATA TAKEN 31 MAY BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 1.20 1/17.57/100/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.84 INCHES HG

N RUN	POR (INCHES OF WATER)	OPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	5.6	5.0	150.0	150.0	72.0	2.60	2.28	2.28	0.0
2	6.2	5.0	151.0	151.0	72.0	3.20	1.68	1.68	0.785
3	6.7	5.0	152.0	152.0	72.0	3.70	1.14	1.14	1.767
4	7.1	5.0	153.0	153.0	72.0	4.10	0.70	0.70	3.142
5	7.6	5.0	153.0	153.0	72.0	4.60	0.29	0.29	6.284
6	7.8	5.0	149.0	149.0	72.0	4.75	0.14	0.14	9.621
7	7.8	5.0	149.0	149.0	72.0	4.80	0.08	0.08	13.548
8	7.8	5.0	150.0	150.0	72.0	4.80	0.06	0.06	15.512
9	7.8	5.0	145.0	145.0	72.0	4.80	0.05	0.05	17.082
10	7.9	5.0	146.0	146.0	72.0	4.90	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*T**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3348	0.8721	0.3839	0.0	0.187	0.0	175.02	58.34	58.34	0.048
2	0.1845	0.2459	0.8706	0.2825	0.1736	0.187	0.035	175.04	67.64	58.34	0.048
3	0.3427	0.1673	0.8692	0.1925	0.3222	0.187	0.064	175.07	75.65	58.35	0.048
4	0.4784	0.1030	0.8678	0.1186	0.4495	0.187	0.089	175.13	82.54	58.37	0.048
5	0.6146	0.0426	0.8678	0.0491	0.5774	0.187	0.115	175.02	89.44	58.34	0.048
6	0.6561	0.0210	0.8735	0.0240	0.6182	0.188	0.123	174.43	91.52	58.14	0.048
7	0.6715	0.0111	0.8735	0.0127	0.6327	0.188	0.126	174.41	92.29	58.13	0.048
8	0.6882	0.0089	0.8721	0.0102	0.6482	0.188	0.129	174.55	93.16	58.18	0.048
9	0.6891	0.0074	0.8793	0.0085	0.6511	0.188	0.130	173.82	93.15	57.94	0.048
10	*****	0.0	0.8778	0.0	*****	0.188	*****	173.95	*****	57.98	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(c) S/D = 1.0, $M_u = 0.048$

Table IX. Continued.

DATA TAKEN 3 JUNE 77 BY PETE HARRELL

CNE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0

1/17-57/0/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	PCR (INCHES CF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	16.5	15.0	150.0	150.0	70.0	7.50	7.20	7.20	0.0	100.16	100.16	0.083
2	18.1	15.0	151.0	151.0	70.0	9.20	5.40	5.40	0.785	116.74	100.02	0.083
3	19.7	15.0	151.0	151.0	70.0	10.70	5.82	3.82	1.767	131.58	99.85	0.082
4	21.0	15.0	151.0	151.0	70.0	12.00	2.43	2.43	3.142	144.76	99.69	0.082
5	22.4	15.0	152.0	152.0	70.0	13.40	1.01	1.01	6.284	157.78	99.60	0.082
6	22.9	15.0	152.0	152.0	70.0	13.90	0.50	0.50	9.621	162.12	95.54	0.082
7	23.2	15.0	153.0	153.0	70.0	14.20	0.27	0.27	13.548	164.47	99.59	0.082
8	23.2	15.0	154.0	154.0	70.0	14.20	0.20	0.20	15.512	163.58	99.67	0.082
9	23.2	15.0	155.0	155.0	70.0	14.20	0.16	0.16	17.082	162.69	99.75	0.082
10	23.4	15.0	146.0	146.0	70.0	14.40	0.0	0.0	*****	*****	98.99	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PHS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PHS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(d) S/D = 0.0, $M_u = 0.082$

Table IX. Continued.

DATA TAKEN 3 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0

1/1/7-57/0/10

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 22.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	POK (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PJ-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)
1	10.9	10.0	153.0	153.0	71.0	4.90	4.69	4.69	0.0
2	12.1	10.0	152.0	152.0	71.0	6.10	3.57	3.57	0.785
3	13.2	10.0	152.0	152.0	71.0	7.10	2.49	2.49	1.767
4	14.0	10.0	150.0	150.0	71.0	8.00	1.61	1.61	3.142
5	14.9	10.0	150.0	150.0	71.0	8.80	0.66	0.66	6.284
6	15.3	10.0	151.0	151.0	71.0	9.20	0.34	0.34	9.621
7	15.4	10.0	151.0	151.0	71.0	9.30	0.18	0.18	13.548
8	15.4	10.0	151.0	151.0	71.0	9.30	0.14	0.14	15.512
9	15.4	10.0	151.0	151.0	71.0	9.40	0.12	0.12	17.082
10	15.6	10.0	147.0	147.0	71.0	9.60	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W* T**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3455	0.8652	0.3989	0.0	0.264	0.0	247.04	82.34	82.34	0.068
2	0.1906	0.2642	0.8676	0.3055	0.1790	0.264	0.050	246.47	95.73	82.15	0.068
3	0.3578	0.1847	0.8676	0.2129	0.3361	0.265	0.095	246.20	107.66	82.06	0.068
4	0.5102	0.1201	0.8704	0.1380	0.4800	0.265	0.135	245.50	118.51	81.83	0.068
5	0.6527	0.0493	0.8704	0.0567	0.6140	0.266	0.173	245.28	128.79	81.76	0.068
6	0.7175	0.0254	0.8690	0.0292	0.6745	0.266	0.191	245.36	133.48	81.78	0.068
7	0.7550	0.0134	0.8690	0.0155	0.6910	0.266	0.195	245.33	134.75	81.77	0.069
8	0.7422	0.0105	0.8690	0.0120	0.6977	0.266	0.197	245.33	135.27	81.77	0.068
9	0.7408	0.0086	0.8690	0.0059	0.6964	0.266	0.197	245.28	135.14	81.75	0.067
10	*****	0.0	0.8747	0.0	*****	0.267	*****	244.41	*****	81.47	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PHS(IN. H2O):	-1.33	-1.17	-0.88	-0.66	-0.49	-0.31	-0.21	-0.12	-0.06	-0.04	0.02	-0.01	0.00
PHS%:	-0.10	-0.09	-0.07	-0.05	0.04	-0.02	0.02	-0.01	-0.00	-0.00	0.00	-0.00	0.00

(e) S/D = 0.0, $M_u = 0.068$

Table IX. Continued.

DATA TAKEN 3 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0 1/17.57/0/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.80 INCHES HG

N	POR	OPCR	IOR	IUPI	TAHB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA	
RUN	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(SQ INCHES)						
1	5.5	5.0	152.0	152.0	71.0	2.50	2.34	2.34	0.0	
2	6.0	5.0	152.0	152.0	71.0	3.00	1.75	1.75	0.785	
3	6.7	5.0	152.0	152.0	71.0	3.60	1.26	1.26	1.767	
4	7.0	5.0	152.0	152.0	71.0	4.00	0.79	0.79	3.142	
5	7.5	5.0	152.0	152.0	71.0	4.50	0.32	0.32	6.284	
6	7.6	5.0	151.0	151.0	71.0	4.60	0.16	0.16	9.621	
7	7.6	5.0	151.0	151.0	71.0	4.70	0.09	0.09	13.548	
8	7.7	5.0	149.0	149.0	71.0	4.70	0.07	0.07	15.512	
9	7.8	5.0	147.0	147.0	71.0	4.80	0.05	0.05	17.082	
10	7.9	5.0	143.0	143.0	71.0	4.80	0.0	0.0	*****	

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UM	UU	UPT MACH
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	
1	0.0	0.3418	0.8676	0.3939	0.0	0.187	0.0	175.44	58.48	58.48	0.048
2	0.1890	0.2559	0.8676	0.2950	0.1775	0.187	0.035	175.33	67.93	58.44	0.048
3	0.3607	0.1845	0.8676	0.2126	0.3388	0.187	0.067	175.22	76.58	58.40	0.048
4	0.5076	0.1158	0.8676	0.1335	0.4769	0.187	0.095	175.11	84.00	58.37	0.048
5	0.6458	0.0470	0.8676	0.0541	0.6066	0.187	0.121	175.01	91.00	58.33	0.048
6	0.6985	0.0235	0.8690	0.0271	0.6566	0.187	0.131	174.84	93.67	58.28	0.048
7	0.7169	0.0125	0.8690	0.0144	0.6739	0.187	0.134	174.80	94.60	58.26	0.048
8	0.7165	0.0096	0.8719	0.0110	0.6745	0.188	0.134	174.53	94.57	58.17	0.048
9	0.7245	0.0081	0.8747	0.0093	0.6831	0.188	0.136	174.23	94.97	58.07	0.048
10	*****	0.0	0.8805	0.0	*****	0.188	*****	173.67	*****	57.89	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS%:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(f) S/D = 0.0, $M_u = 0.048$

Table IX. Continued.

DATA TAKEN 3 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24 1/1/7.57/-024/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.81 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	16.6	15.0	148.0	148.0	73.0	7.60	7.08	7.08	0.0	99.97	99.97	0.083
2	18.2	15.0	148.0	148.0	73.0	9.20	5.40	5.40	0.785	116.57	99.77	0.083
3	19.7	15.0	148.0	148.0	73.0	10.70	3.84	3.84	1.767	131.55	99.59	0.082
4	20.9	15.0	148.0	148.0	73.0	11.90	2.42	2.42	3.142	144.42	99.44	0.082
5	22.2	15.0	148.0	148.0	73.0	13.20	1.01	1.01	6.284	157.72	99.29	0.082
6	22.6	15.0	148.0	148.0	73.0	13.60	0.50	0.50	9.621	162.20	99.24	0.082
7	22.8	15.0	148.0	148.0	73.0	13.80	0.27	0.27	13.548	164.38	99.21	0.082
8	22.9	15.0	148.0	148.0	73.0	13.90	0.20	0.20	15.512	163.42	99.20	0.082
9	22.9	15.0	148.0	148.0	73.0	13.90	0.17	0.17	17.082	164.40	99.20	0.082
10	23.1	15.0	151.0	151.0	73.0	14.10	0.0	0.0	*****	*****	99.42	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PHS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM5%:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(g) S/D = -0.24, $M_u = 0.082$

Table IX. Continued.

DATA TAKEN 3 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24 1/17.57/-024/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.81 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	11.1	10.0	147.0	147.0	73.0	5.00	4.72	4.72	0.0
2	12.1	10.0	147.0	147.0	73.0	6.10	3.58	3.58	0.785
3	13.1	10.0	147.0	147.0	73.0	7.00	2.50	2.50	1.767
4	13.9	10.0	147.0	147.0	73.0	7.90	1.62	1.62	3.142
5	14.7	10.0	147.0	147.0	73.0	8.70	0.67	0.67	6.284
6	15.0	10.0	147.0	147.0	73.0	9.00	0.33	0.33	9.621
7	15.2	10.0	147.0	147.0	73.0	9.20	0.18	0.18	13.548
8	15.2	10.0	147.0	147.0	73.0	9.20	0.13	0.13	15.512
9	15.2	10.0	147.0	147.0	73.0	9.20	0.11	0.11	17.082
10	15.4	10.0	147.0	147.0	73.0	9.30	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*/T**44	WP	WS (LBM/SEC)	UP (FT/SEC)	UN (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3524	0.8780	0.4014	0.0	0.265	0.0	245.79	81.93	81.93	0.068
2	0.1897	0.2681	0.8780	0.3054	0.1791	0.266	0.050	245.43	95.47	81.81	0.068
3	0.3564	0.1876	0.8780	0.2137	0.3366	0.266	0.095	245.19	107.47	81.72	0.068
4	0.5097	0.1219	0.8780	0.1388	0.4813	0.266	0.136	244.89	118.54	81.62	0.068
5	0.6549	0.0505	0.8780	0.0575	0.6185	0.266	0.174	244.65	125.08	81.54	0.068
6	0.7035	0.0249	0.8780	0.0283	0.6643	0.266	0.187	244.56	132.60	81.51	0.068
7	0.7314	0.0136	0.8780	0.0155	0.6907	0.267	0.195	244.50	134.64	81.49	0.068
8	0.7117	0.0098	0.8780	0.0112	0.6721	0.267	0.190	244.50	133.20	81.49	0.068
9	0.7209	0.0083	0.8780	0.0095	0.6808	0.267	0.192	244.50	133.87	81.49	0.068
10	*****	0.0	0.8780	0.0	*****	0.267	*****	244.50	*****	81.49	0.068

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS(IN. H2O):	-1.41	-1.30	-1.09	-0.87	-0.67	-0.47	-0.34	-0.22	-0.16	-0.11	-0.03	-0.04	-0.02
PMS%:	-0.11	-0.10	-0.08	-0.07	-0.05	-0.04	-0.03	-0.02	-0.01	-0.01	-0.00	-0.00	-0.00

(h) S/D = -0.24, $M_u = 0.068$

Table IX. Continued.

DATA TAKEN 3 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24

1/17.57/-024/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.81 INCHES HG

N RUN	PCR (INCHES OF WATER)	DPCR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UH (FT/SEC)	UU (FT/SEC)	UPT MACH
1	5.5	5.0	149.0	149.0	73.0	2.50	2.34	2.34	0.0	58.32	58.32	0.048
2	6.1	5.0	150.0	150.0	73.0	3.10	1.79	1.79	0.785	67.96	58.33	0.048
3	6.6	5.0	150.0	150.0	73.0	3.50	1.26	1.26	1.767	76.50	58.31	0.048
4	6.9	5.0	151.0	151.0	73.0	3.90	0.78	0.78	3.142	83.78	58.32	0.048
5	7.4	5.0	151.0	151.0	73.0	4.40	0.32	0.32	6.284	91.20	58.28	0.048
6	7.5	5.0	149.0	149.0	73.0	4.50	0.16	0.16	9.621	93.68	58.18	0.048
7	7.6	5.0	149.0	149.0	73.0	4.60	0.09	0.09	13.548	94.61	58.17	0.048
8	7.6	5.0	149.0	149.0	73.0	4.60	0.07	0.07	15.512	94.66	58.17	0.048
9	7.7	5.0	146.0	146.0	73.0	4.60	0.05	0.05	17.082	95.02	58.04	0.048
10	7.7	5.0	147.0	147.0	73.0	4.70	0.0	0.0	*****	*****	58.07	0.048

N RUN	W*	P*	T*	P*/T*	W*T**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UH (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3448	0.8751	0.3939	0.0	0.187	0.0	174.98	58.32	58.32	0.048
2	0.1904	0.2637	0.8737	0.3018	0.1795	0.187	0.036	175.00	67.96	58.33	0.048
3	0.3587	0.1850	0.8737	0.2118	0.3380	0.187	0.067	174.93	76.50	58.31	0.048
4	0.5015	0.1142	0.8723	0.1309	0.4722	0.187	0.094	174.97	83.78	58.32	0.048
5	0.6471	0.0477	0.8723	0.0546	0.6094	0.187	0.121	174.86	91.20	58.28	0.048
6	0.6561	0.0237	0.8751	0.0271	0.6564	0.188	0.131	174.55	93.68	58.18	0.048
7	0.7144	0.0126	0.8751	0.0144	0.6736	0.188	0.134	174.53	94.61	58.17	0.048
8	0.7152	0.0096	0.8751	0.0110	0.6745	0.188	0.134	174.53	94.66	58.17	0.048
9	0.7226	0.0082	0.8795	0.0093	0.6029	0.188	0.136	174.12	95.02	58.04	0.048
10	*****	0.0	0.8780	0.0	*****	0.188	*****	174.22	*****	58.07	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 0.5 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
 PMS(IN-H2O): 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 PMS*: 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

(i) S/D = -0.24, $M_u = 0.048$

Table IX. Continued.

DATA TAKEN 8 JUN 77 BY PETE HARRELL

CONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/17.57/-084/13

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.65 INCHES HG

N	POR	DPOR	TDR	TUPT	TAMB	PU-PA	PA-PS	PA-PN2	SECONDARY AREA	UW	UPT MACH
RUN	(INCHES)	CF WATER		(DEGREES FAHRENHEIT)		(INCHES OF WATER)	(INCHES OF WATER)		(SQ. INCHES)	(FT/SEC)	(FT/SEC)
1	16.6	15.0	149.0	149.0	70.0	7.60	7.00	7.00	0.0	100.32	0.083
2	18.0	15.0	149.0	149.0	70.0	9.00	5.38	5.38	0.785	116.88	0.083
3	19.2	15.0	149.0	149.0	70.0	10.20	3.66	3.66	1.767	131.14	0.083
4	20.1	15.0	149.0	149.0	70.0	11.10	2.16	2.16	3.142	142.48	0.083
5	20.9	15.0	149.0	149.0	70.0	11.90	0.85	0.85	6.284	153.29	0.083
6	21.1	15.0	149.0	149.0	70.0	12.10	0.41	0.41	9.621	156.67	0.082
7	21.1	15.0	148.0	148.0	70.0	12.20	0.21	0.21	13.548	157.02	0.082
8	21.2	15.0	148.0	148.0	70.0	12.30	0.16	0.16	15.512	158.94	0.082
9	21.2	15.0	148.0	148.0	70.0	12.30	0.14	0.14	17.082	158.94	0.082
10	21.3	15.0	145.0	145.0	70.0	12.40	0.0	0.0	*****	158.94	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN 10

X/D: 0.0 0.5 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
 PMS (IN. H2O): 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 PMS*: 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

(j) S/D = -0.84, $M_u = 0.082$

Table IX. Continued.

DATA TAKEN 7 JUN 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/7.57/ 084/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.752 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

INTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.74 INCHES HG

N RUN	POR (INCHES OF WATER)	OPOR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT (DEGREES FAHRENHEIT)	TAMB	PJ-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UN (FT/SEC)	UU (FT/SEC)	UP (FT/SEC)	WS (LBH/SEC)	WP (LBH/SEC)	WPT**44	P*/T*	T*	P*	W*	N RUN	UPT MACH
1	11.0	10.0	146.0	146.0	70.0	5.00	4.58	4.58	0.0	81.94	81.94	245.84	0.0	0.265	0.0	0.3896	0.8745	0.3407	0.0	1	0.068
2	12.0	10.0	146.0	146.0	70.0	6.00	3.55	3.55	0.785	95.41	81.84	245.54	0.050	0.265	0.1785	0.3027	0.8745	0.2647	0.1893	2	0.068
3	12.8	10.0	146.0	146.0	70.0	6.80	2.35	2.39	1.767	106.87	81.76	245.30	0.093	0.266	0.3293	0.2042	0.8745	0.1786	0.3493	3	0.068
4	13.4	10.0	146.0	146.0	70.0	7.40	1.48	1.48	3.142	116.89	81.70	245.11	0.130	0.266	0.4604	0.1266	0.8745	0.1108	0.4084	4	0.068
5	13.5	10.0	146.0	146.0	70.0	7.90	0.57	0.57	6.284	125.37	81.65	244.96	0.161	0.266	0.5711	0.0488	0.8745	0.0427	0.6058	5	0.068
6	14.1	10.0	146.0	146.0	70.0	8.00	0.27	0.27	9.621	127.73	81.65	244.96	0.170	0.266	0.6017	0.0231	0.8745	0.0202	0.6382	6	0.068
7	14.1	10.0	146.0	146.0	70.0	8.10	0.14	0.14	13.548	128.35	81.63	244.90	0.172	0.266	0.6101	0.0120	0.8745	0.0105	0.6472	7	0.068
8	14.1	10.0	146.0	146.0	70.0	8.10	0.11	0.11	15.512	129.05	81.63	244.90	0.175	0.266	0.6192	0.0094	0.8745	0.0082	0.6568	8	0.068
9	14.1	10.0	146.0	146.0	70.0	8.10	0.09	0.09	17.082	129.05	81.63	244.90	0.174	0.266	0.6168	0.0077	0.8745	0.0067	0.6542	9	0.068
10	14.2	10.0	145.0	145.0	70.0	8.20	0.0	0.0	*****	128.87	81.63	244.67	*****	0.266	*****	0.0	0.8760	0.0	*****	10	0.068

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
 PMS(IN. H2O): -1.50 -1.31 -1.18 -1.10 -0.55 -0.72 -0.55 -0.40 -0.28 -0.21 -0.10 -0.09 0.01
 PMS*: -0.11 -0.10 -0.09 -0.08 -0.07 -0.05 -0.04 -0.03 -0.02 -0.01 -0.01 0.00

(k) S/D = -0.84, $M_u = 0.068$

Table IX. Continued.

DATA TAKEN 8 JUN 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/77.51/ J84/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AH/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.65 INCHES HG

N RUN	POR (INCHES OF WATER)	TUR	TUT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UPT (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT RACH
1	5.5	5.0	146.0	146.0	70.0	2.50	2.28	2.28	0.0	58.33	58.33	0.048
2	6.0	5.0	146.0	146.0	70.0	3.00	1.76	1.76	0.785	58.30	58.30	0.048
3	6.4	5.0	146.0	146.0	70.0	3.35	1.20	1.20	1.767	58.27	58.27	0.048
4	6.6	5.0	146.0	146.0	70.0	3.60	0.72	0.72	3.142	58.25	58.25	0.048
5	6.9	5.0	145.0	145.0	70.0	3.90	0.28	0.28	6.284	58.18	58.18	0.048
6	7.0	5.0	145.0	145.0	70.0	4.00	0.13	0.13	9.621	58.18	58.18	0.048
7	7.0	5.0	145.0	145.0	70.0	4.00	0.07	0.07	13.548	58.18	58.18	0.048
8	7.0	5.0	145.0	145.0	70.0	4.00	0.05	0.05	15.512	58.18	58.18	0.048
9	7.0	5.0	145.0	145.0	70.0	4.00	0.04	0.04	17.082	58.18	58.18	0.048
10	7.1	5.0	145.0	145.0	70.0	4.10	0.0	0.0	*****	58.17	58.17	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS%:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(1) S/D = -0.84, $M_u = 0.048$

Table IX. Continued.

DATA TAKEN 29 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0

1/1/5.57/0/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 16.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 5.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.78 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	FOR (DEGREES FAHRENHEIT)	TAMB	PJ-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UPT MACH
1	16.5	15.0	149.0	73.0	7.50	7.26	7.26	0.0	0.083
2	18.2	15.0	149.0	73.0	9.20	5.38	5.38	0.785	0.083
3	19.8	15.0	149.0	73.0	10.80	3.77	3.77	1.767	0.082
4	21.2	15.0	149.0	73.0	12.20	2.37	2.37	3.142	0.082
5	22.6	15.0	150.0	73.0	13.50	0.99	0.99	6.284	0.082
6	23.0	15.0	151.0	73.0	14.00	0.49	0.49	9.621	0.082
7	23.2	15.0	152.0	73.0	14.20	0.26	0.26	13.548	0.082
8	23.2	15.0	153.0	73.0	14.20	0.20	0.20	15.512	0.082
9	23.3	15.0	153.0	73.0	14.30	0.16	0.16	17.082	0.082
10	23.4	15.0	149.0	73.0	14.40	0.0	0.0	*****	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS%:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(a) S/D = 0.0, $M_u = 0.082$

Table X. Single-Nozzle Performance Data for L/D = 5.57, Elliptic Transition.

DATA TAKEN 29 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0 1/1/5.57/0/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 16.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 5.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.78 INCHES HG

N RUN	POR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PJ-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UH (FT/SEC)	UU (FT/SEC)	UPT MACH
1	10.9	150.0	150.0	74.0	4.90	4.78	4.78	0.0	82.16	82.16	0.068
2	12.1	151.0	151.0	74.0	6.10	3.54	3.54	0.785	95.70	82.11	0.068
3	13.2	151.0	151.0	74.0	7.20	2.46	2.46	1.767	107.56	82.00	0.068
4	14.1	152.0	152.0	74.0	8.10	1.60	1.60	3.142	118.67	81.98	0.068
5	14.9	153.0	153.0	74.0	8.90	0.66	0.66	6.284	129.15	81.96	0.068
6	15.2	153.0	153.0	74.0	9.20	0.33	0.33	9.621	133.04	81.93	0.068
7	15.4	152.0	152.0	74.0	9.40	0.17	0.17	13.548	133.51	81.85	0.068
8	15.4	152.0	152.0	74.0	9.40	0.13	0.13	15.512	133.58	81.85	0.068
9	15.5	152.0	152.0	74.0	9.50	0.11	0.11	17.082	134.24	81.84	0.068
10	15.6	148.0	148.0	74.0	9.60	0.0	0.0	*****	*****	81.56	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
PMSI IN. H2O:	-1.28	-1.13	-0.85	-0.59	-0.44	-0.23	-0.13	-0.07	0.0
PMSI:	-0.10	-0.09	-0.06	-0.04	-0.03	-0.02	-0.01	-0.01	0.0

(b) S/D = 0.0, $M_u = 0.068$

Table X. Continued.

DATA TAKEN 29 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0

1/1/5-57/0/05

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 16.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 5.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AN/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.78 INCHES HG

N RUN	W*	P*	T*	P*/T*	W*/T*	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
	POR (INCHES OF WATER)	DPOR	YOK (DEGREES FAHRENHEIT)	YUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)		
1	5.5	5.0	149.0	149.0	74.0	2.50	2.37	2.37	0.0		
2	6.1	5.0	149.0	149.0	74.0	3.00	1.78	1.78	0.785		
3	6.7	5.0	149.0	149.0	74.0	3.60	1.25	1.25	1.767		
4	7.1	5.0	149.0	149.0	74.0	4.00	0.78	0.78	3.142		
5	7.5	5.0	149.0	149.0	74.0	4.50	0.32	0.32	6.284		
6	7.6	5.0	149.0	149.0	74.0	4.60	0.16	0.16	9.621		
7	7.7	5.0	149.0	149.0	74.0	4.70	0.08	0.08	13.548		
8	7.7	5.0	149.0	149.0	74.0	4.70	0.06	0.06	15.512		
9	7.8	5.0	149.0	149.0	74.0	4.80	0.05	0.05	17.082		
10	7.0	5.0	146.0	146.0	74.0	4.80	0.0	0.0	*****		

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
PHS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(c) S/D = 0.0, $M_u = 0.048$

Table X. Continued.

DATA TAKEN 8 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24 1/1/5.57/-024/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 16.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 5.57

JPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.84 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	16.4	15.0	154.0	154.0	73.0	7.50	7.10	7.10	0.0
2	18.2	15.0	154.0	154.0	73.0	9.20	5.41	5.41	0.785
3	19.8	15.0	154.0	154.0	73.0	10.80	3.76	3.76	1.767
4	21.1	15.0	154.0	154.0	73.0	12.00	2.33	2.33	3.142
5	22.4	15.0	154.0	154.0	73.0	13.40	0.97	0.97	6.284
6	22.7	15.0	154.0	154.0	73.0	13.70	0.48	0.48	9.621
7	23.0	15.0	154.0	154.0	73.0	14.00	0.25	0.25	13.548
8	23.0	15.0	154.0	154.0	73.0	14.00	0.19	0.19	15.512
9	23.1	15.0	155.0	155.0	73.0	14.10	0.16	0.16	17.082
10	23.2	15.0	154.0	154.0	73.0	14.10	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*T**44	HP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UH (FT/SEC)	UU (FT/SEC)	UPT MAC+
1	0.0	0.3526	0.8680	0.4062	0.0	0.324	0.0	301.24	100.41	100.41	0.083
2	0.1910	0.2697	0.8680	0.3107	0.1795	0.324	0.062	300.64	116.98	100.21	0.083
3	0.3578	0.1882	0.8680	0.2168	0.3362	0.325	0.116	300.05	131.56	100.01	0.082
4	0.5001	0.1169	0.8680	0.1347	0.4699	0.325	0.163	299.65	144.11	99.88	0.082
5	0.6443	0.0489	0.8680	0.0563	0.6054	0.326	0.210	299.10	156.85	99.69	0.082
6	0.6901	0.0235	0.8680	0.0276	0.6484	0.326	0.225	298.59	160.51	99.66	0.082
7	0.7047	0.0126	0.8680	0.0145	0.6622	0.326	0.230	298.88	162.21	99.62	0.082
8	0.7034	0.0096	0.8680	0.0110	0.6610	0.326	0.229	298.88	162.09	99.62	0.082
9	0.7113	0.0081	0.8666	0.0093	0.6679	0.326	0.232	299.09	162.81	99.69	0.082
10	*****	0.0	0.8680	0.0	*****	0.326	*****	298.88	*****	99.62	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
PMS (IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(d) S/D = -0.24, $M_u = 0.082$

Table X. Continued.

DATA TAKEN 8 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24 1/1/5.57/-0.24/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 16.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 5.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AH/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE REYNOLDS: 0.70
 AMBIENT PRESSURE: 29.84 INCHES HG

N RUN	POR (INCHES OF WATER)	OPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	P(U-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQAKE INCHES)	UM	UU (FT/SEC)	UPT MACH
1	5.5	5.0	149.0	149.0	73.0	2.40	2.32	2.32	0.0			0.048
2	6.1	5.0	149.0	149.0	73.0	3.00	1.79	1.79	0.785			0.048
3	6.6	5.0	149.0	149.0	73.0	3.50	1.23	1.23	1.767			0.048
4	7.0	5.0	149.0	149.0	73.0	3.90	0.77	0.77	3.142			0.048
5	7.4	5.0	149.0	149.0	73.0	4.40	0.32	0.32	6.284			0.048
6	7.6	5.0	149.0	149.0	73.0	4.60	0.16	0.16	9.621			0.048
7	7.6	5.0	149.0	149.0	73.0	4.60	0.09	0.09	13.548			0.048
8	7.7	5.0	149.0	149.0	73.0	4.60	0.07	0.07	15.512			0.048
9	7.7	5.0	149.0	149.0	73.0	4.60	0.05	0.05	17.082			0.048
10	7.7	5.0	149.0	149.0	73.0	4.70	0.0	0.0	*****			0.048
N RUN	W*	P*	T*	P*/T*	W*/T*.44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH	
1	0.0	0.3416	0.8751	0.3904	0.0	0.187	0.0	174.93	58.31	58.31	0.048	
2	0.1903	0.2640	0.8751	0.3016	0.1794	0.187	0.036	174.80	67.89	58.26	0.048	
3	0.3549	0.1816	0.8751	0.2075	0.3346	0.187	0.067	174.69	76.24	58.23	0.048	
4	0.4974	0.1131	0.8751	0.1292	0.4690	0.187	0.093	174.60	83.49	58.20	0.048	
5	0.6431	0.0474	0.8751	0.0541	0.6064	0.188	0.121	174.48	90.91	58.16	0.048	
6	0.6960	0.0237	0.8751	0.0271	0.6563	0.188	0.131	174.43	93.62	58.14	0.048	
7	0.7351	0.0133	0.8751	0.0152	0.6932	0.188	0.138	174.43	95.62	58.14	0.048	
8	0.7152	0.0096	0.8751	0.0110	0.6744	0.188	0.134	174.45	94.61	58.15	0.048	
9	0.6907	0.0074	0.8751	0.0085	0.6514	0.188	0.130	174.45	93.36	58.15	0.048	
10	*****	0.0	0.8751	0.0	*****	0.188	*****	174.41	*****	58.13	0.048	

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
PHS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PHS%:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(f) S/D = -0.24, $M_u = 0.048$

Table X. Continued.

DATA TAKEN 28 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/5.57/-084/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 16.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 5.57

INLET DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.85 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PJ-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UU (FT/SEC)	UM (FT/SEC)	UP (FT/SEC)	WS (LBM/SEC)	WP (LBM/SEC)	WT+T+44	P+T+	T+	P+	W+	N RUN	UPT NAC+1
1	16.5	15.0	154.0	154.0	71.0	7.50	7.00	7.00	0.0	100.40	100.40	301.22	0.0	0.324	0.0	0.4004	0.8647	0.5462	0.0	1	0.083
2	18.1	15.0	153.0	153.0	71.0	9.10	5.20	5.20	0.785	100.12	116.52	300.39	0.061	0.325	0.1760	0.2986	0.8662	0.2586	0.1875	2	0.083
3	19.5	15.0	151.0	151.0	71.0	10.50	3.47	3.47	1.767	99.79	130.03	299.38	0.112	0.326	0.3231	0.1999	0.8690	0.1737	0.3437	3	0.082
4	20.4	15.0	154.0	154.0	71.0	11.40	2.07	2.07	3.142	99.92	141.48	299.78	0.154	0.325	0.4433	0.1195	0.8647	0.1034	0.4726	4	0.082
5	21.2	15.0	155.0	155.0	71.0	12.20	0.79	0.79	6.284	99.91	151.29	299.73	0.190	0.325	0.5473	0.0457	0.8633	0.0395	0.5839	5	0.082
6	21.4	15.0	155.0	155.0	71.0	12.40	0.38	0.38	9.621	99.88	154.46	299.66	0.202	0.325	0.5810	0.0220	0.8633	0.0190	0.6198	6	0.082
7	21.5	15.0	152.0	152.0	71.0	12.50	0.20	0.20	13.548	99.62	155.44	298.89	0.206	0.326	0.5933	0.0116	0.8676	0.0100	0.6316	7	0.082
8	21.5	15.0	152.0	152.0	71.0	12.50	0.15	0.15	15.512	99.62	154.96	298.89	0.204	0.326	0.5883	0.0087	0.8676	0.0075	0.6263	8	0.082
9	21.5	15.0	153.0	153.0	71.0	12.50	0.12	0.12	17.082	99.71	154.20	299.14	0.201	0.326	0.5795	0.0069	0.8662	0.0060	0.6174	9	0.082
10	21.7	15.0	150.0	150.0	71.0	12.70	0.0	0.0	*****	99.44	*****	298.33	*****	0.327	*****	0.0	0.8704	0.0	*****	10	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	3.0	3.5	4.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS%:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(g) S/D = -0.84, $M_u = 0.082$

Table X. Continued.

DATA TAKEN 28 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/5.57/-084/10

NUMBER OF PRIMARY NOZZLES: 1
 UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.85 INCHES HG

PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 16.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 5.57

N	POR	DPOR	TOR	TUPT	TAMB	PJ-PA	PA-PS	PA-PNZ	SECONDARY AREA	
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(SQ. INCHES)	
1	11.0	10.0	152.0	152.0	72.0	5.00	4.60	4.60	0.0	
2	12.1	10.0	153.0	153.0	72.0	6.00	3.48	3.48	0.785	
3	12.5	10.0	153.0	153.0	72.0	6.90	2.28	2.28	1.767	
4	13.5	10.0	150.0	150.0	72.0	7.50	1.38	1.38	3.142	
5	14.1	10.0	150.0	150.0	72.0	8.00	0.53	0.53	6.284	
6	14.2	10.0	150.0	150.0	72.0	8.20	0.25	0.25	9.621	
7	14.2	10.0	150.0	150.0	72.0	8.20	0.13	0.13	13.548	
8	14.3	10.0	150.0	150.0	72.0	8.20	0.10	0.10	15.512	
9	14.3	10.0	150.0	150.0	72.0	8.30	0.08	0.08	17.082	
10	14.4	10.0	145.0	145.0	72.0	8.40	0.0	0.0	*****	

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UM	UU	UPT
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	MACH
1	0.0	0.3401	0.8692	0.3913	0.0	0.264	0.0	246.59	82.19	82.19	0.068
2	0.1881	0.2575	0.8678	0.2967	0.1768	0.264	0.050	246.52	95.58	82.17	0.068
3	0.3425	0.1691	0.8678	0.1949	0.3217	0.265	0.091	246.22	106.55	82.07	0.068
4	0.4722	0.1030	0.8721	0.1181	0.4446	0.256	0.125	245.43	115.76	81.81	0.068
5	0.5849	0.0396	0.8721	0.0454	0.5507	0.266	0.155	245.31	123.90	81.77	0.068
6	0.6150	0.0187	0.8721	0.0214	0.5790	0.266	0.163	245.22	126.05	81.74	0.068
7	0.6245	0.0097	0.8721	0.0111	0.5880	0.266	0.166	245.22	126.74	81.74	0.068
8	0.6270	0.0075	0.8721	0.0086	0.5904	0.266	0.167	245.25	126.94	81.75	0.068
9	0.6176	0.0060	0.8721	0.0069	0.5815	0.266	0.164	245.19	126.24	81.73	0.068
10	*****	0.0	0.8793	0.0	*****	0.267	*****	244.15	*****	81.38	0.068

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
PMS(IN. H2O):	-1.32	-1.18	-1.03	-0.94	-0.77	-0.55	-0.34	-0.20	-0.07
PMS%:	-0.10	-0.09	-0.08	-0.07	-0.06	-0.04	-0.03	-0.01	-0.00

(h) S/D = -0.84, $M_u = 0.068$

Table X. Continued.

DATA TAKEN 28 JUNE 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/5.57/-084/05

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 16.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 5.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.85 INCHES HG

N RUN	POR (INCHES GF WATER)	TOR	TEMP (DEGREES FAHRENHEIT)	TAMP	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	5.5	152.0	152.0	72.0	2.50	2.27	2.27	0.0
2	6.0	152.0	152.0	72.0	3.00	1.71	1.71	0.785
3	6.5	152.0	152.0	72.0	3.50	1.17	1.17	1.767
4	6.8	152.0	152.0	72.0	3.80	0.69	0.69	3.142
5	7.0	152.0	152.0	72.0	4.00	0.26	0.26	6.284
6	7.1	151.0	151.0	72.0	4.10	0.13	0.13	5.621
7	7.1	151.0	151.0	72.0	4.10	0.07	0.07	13.548
8	7.1	151.0	151.0	72.0	4.10	0.05	0.05	15.512
9	7.2	151.0	151.0	72.0	4.10	0.04	0.04	17.082
10	7.3	143.0	143.0	72.0	4.20	0.0	0.0	*****

N RUN	W*	P*	T*	PA/T*	W* (LB/SEC)	WP (LB/SEC)	WS (LB/SEC)	UP (FT/SEC)	UM (FT/SEC)	UIJ (FT/SEC)	UPT MAC-1
1	0.0	0.3322	0.8692	0.3822	0.0	0.187	0.0	175.29	58.43	58.43	0.048
2	0.1866	0.2505	0.8692	0.2882	0.1755	0.187	0.035	175.18	67.77	58.39	0.048
3	0.3473	0.1716	0.8692	0.1975	0.3265	0.147	0.065	175.07	75.87	58.35	0.048
4	0.4741	0.1013	0.8692	0.1165	0.4457	0.187	0.089	175.01	82.29	58.33	0.048
5	0.5819	0.0382	0.8692	0.0439	0.5471	0.187	0.109	174.96	87.76	58.32	0.048
6	0.6172	0.0184	0.8706	0.0211	0.5807	0.187	0.116	174.80	89.54	58.26	0.048
7	0.6503	0.0103	0.8706	0.0118	0.6119	0.187	0.122	174.80	91.22	58.26	0.048
8	0.6600	0.0081	0.8706	0.0093	0.6210	0.187	0.124	174.80	91.72	58.26	0.048
9	0.6574	0.0066	0.8705	0.0076	0.6185	0.187	0.123	174.82	91.59	58.27	0.048
10	*****	0.0	0.8822	0.0	*****	0.189	*****	173.65	*****	57.88	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(i) S/D = -0.84, $M_u = 0.048$

Table X. Continued.

DATA TAKEN 8 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0 1/1/4.57/0/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.84 INCHES HG

N	POR	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA		
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)	(INCHES OF WATER)		(SQUARE INCHES)		
1	16.4	15.0	154.0	154.0	75.0	7.40	7.16	7.16	0.0		
2	18.3	15.0	155.0	155.0	75.0	9.30	5.30	5.30	0.785		
3	19.9	15.0	155.0	155.0	75.0	11.00	3.70	3.70	1.767		
4	21.2	15.0	155.0	155.0	75.0	12.30	2.29	2.29	3.142		
5	22.6	15.0	155.0	155.0	75.0	13.60	0.95	0.95	6.284		
6	23.0	15.0	156.0	156.0	75.0	14.00	0.47	0.47	9.621		
7	23.2	15.0	156.0	156.0	75.0	14.20	0.25	0.25	13.548		
8	23.2	15.0	156.0	156.0	75.0	14.20	0.19	0.19	15.512		
9	23.3	15.0	156.0	156.0	75.0	14.30	0.16	0.16	17.082		
10	23.4	15.0	155.0	155.0	75.0	14.50	0.0	0.0	*****		
N	W*	P*	T*	P*/T*	W*Y**44	YP	WS	UP	UH	UU	UPT MAC+
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	
1	0.0	0.3567	0.8713	0.4094	0.0	0.324	0.0	301.31	100.43	100.43	0.083
2	0.1989	0.2648	0.8698	0.3045	0.1776	0.324	0.061	300.85	116.92	100.28	0.083
3	0.3545	0.1857	0.8698	0.2135	0.3334	0.325	0.115	300.19	131.43	100.06	0.082
4	0.4952	0.1153	0.8698	0.1326	0.4657	0.325	0.161	299.71	143.85	95.90	0.082
5	0.6368	0.0480	0.8698	0.0552	0.5989	0.326	0.207	299.27	156.44	99.75	0.082
6	0.6860	0.0237	0.8684	0.0273	0.6447	0.326	0.223	259.37	160.84	99.78	0.082
7	0.7044	0.0126	0.8684	0.0145	0.6620	0.326	0.229	299.30	162.47	99.76	0.082
8	0.7031	0.0096	0.8684	0.0110	0.6608	0.326	0.229	299.30	162.36	99.76	0.082
9	0.7104	0.0081	0.8684	0.0093	0.6677	0.326	0.231	299.26	163.01	99.75	0.082
10	*****	0.0	0.8698	0.0	*****	0.326	*****	298.91	*****	99.63	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(a) S/D = 0.0, $M_u = 0.082$

Table XI. Single-Nozzle Performance Data for L/D = 4.57, Elliptic Transition

DATA TAKEN 8 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0 1/14-57/0/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.84 INCHES HG

N RUN	POR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UP (FT/SEC)	WS (LBM/SEC)	WD (LBM/SEC)	W+T+44	P+T+44	T+	P+	H+	N	UPT MAC
1	10.9	10.0	154.0	154.0	75.0	4.90	4.75	4.75	0.0	0.0	0.0	0.264	0.0	0.4040	0.8713	0.3520	0.0	0.0	0.069
2	12.1	10.0	154.0	154.0	75.0	6.10	3.52	3.52	0.785	0.0	0.0	0.264	0.050	0.3002	0.8713	0.2616	0.1888	0.0	0.068
3	13.2	10.0	154.0	154.0	75.0	7.20	2.39	2.39	1.767	0.0	0.0	0.265	0.093	0.2044	0.8713	0.1781	0.3498	0.0	0.068
4	14.1	10.0	154.0	154.0	75.0	8.10	1.53	1.53	3.142	0.0	0.0	0.265	0.132	0.1311	0.8713	0.1143	0.4971	0.0	0.068
5	15.1	10.0	155.0	155.0	75.0	9.00	0.63	0.63	6.204	0.0	0.0	0.265	0.169	0.0541	0.8698	0.0471	0.6378	0.0	0.067
6	15.4	10.0	155.0	155.0	75.0	9.30	0.31	0.31	9.621	0.0	0.0	0.265	0.181	0.0266	0.8698	0.0232	0.6847	0.0	0.067
7	15.4	10.0	156.0	156.0	75.0	9.40	0.17	0.17	13.548	0.0	0.0	0.265	0.189	0.0146	0.8684	0.0127	0.7146	0.0	0.067
8	15.5	10.0	156.0	156.0	75.0	9.40	0.13	0.13	15.512	0.0	0.0	0.265	0.189	0.0112	0.8684	0.0097	0.7154	0.0	0.067
9	15.5	10.0	156.0	156.0	75.0	9.50	0.11	0.11	17.082	0.0	0.0	0.265	0.192	0.0095	0.8684	0.0082	0.7247	0.0	0.067
10	15.5	10.0	147.0	147.0	75.0	9.50	0.0	0.0	*****	0.0	0.0	0.267	*****	0.0	0.8813	0.0	*****	0.0	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0
 PMS(IN, H2O): -1.26 -1.09 -0.63 0.52 0.37 -0.26 0.07
 PMS*: -0.10 -0.08 -0.05 -0.04 -0.03 -0.02 -0.01

(b) S/D = 0.0, $M_u = 0.068$

Table XI. Continued.

DATA TAKEN 9 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF 0.0

1/1/4.57/0/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.84 INCHES Hg

N RUN	POR (INCHES OF WATER)	DRUK	TOR (DEGREES FAHRENHEIT)	TUPT	TAHB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UN (FT/SEC)	UPT MACH
1	5.5	5.0	150.0	153.0	75.0	2.50	2.38	2.38	0.0	58.63	58.63	0.048
2	6.1	5.0	150.0	150.0	75.0	3.10	1.76	1.76	0.785	67.87	58.30	0.048
3	6.6	5.0	150.0	150.0	75.0	3.60	1.21	1.21	1.767	76.16	58.26	0.048
4	7.2	5.0	150.0	150.0	75.0	4.10	0.77	0.77	3.142	83.58	58.23	0.048
5	7.6	5.0	150.0	150.0	75.0	4.50	0.31	0.31	6.284	90.52	58.20	0.048
6	7.7	5.0	150.0	150.0	75.0	4.70	0.16	0.16	9.621	93.10	58.18	0.048
7	7.8	5.0	150.0	150.0	75.0	4.70	0.08	0.08	13.548	94.03	58.19	0.048
8	7.8	5.0	150.0	150.0	75.0	4.70	0.06	0.06	15.512	93.88	58.19	0.048
9	7.8	5.0	151.0	151.0	75.0	4.70	0.05	0.05	17.082	93.57	58.24	0.048
10	7.8	5.0	152.0	152.0	75.0	4.70	0.0	0.0	*****	*****	58.28	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0
PMS(LN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(c) S/D = 0.0, $M_u = 0.048$
 Table XI. Continued.

DATA TAKEN 8 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24 1/14.57/-324/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 13.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.84 INCHES HG

N RUN	PUR (INCHES OF WATER)	DPOR	TWK (DEGREES FAHRENHEIT)	TUPT	TAMB	PII-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PN2 (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	16.5	15.0	158.0	158.0	75.0	7.50	7.10	7.10	0.0
2	18.3	15.0	157.0	157.0	75.0	9.30	5.20	5.20	0.785
3	20.0	15.0	156.0	156.0	75.0	11.00	3.59	3.59	1.767
4	21.2	15.0	156.0	156.0	75.0	12.20	2.21	2.21	3.142
5	22.5	15.0	155.0	155.0	75.0	13.40	0.91	0.91	6.284
6	22.8	15.0	155.0	155.0	75.0	13.60	0.45	0.45	9.621
7	22.9	15.0	155.0	155.0	75.0	13.90	0.24	0.24	13.548
8	23.0	15.0	155.0	155.0	75.0	14.00	0.18	0.18	15.512
9	23.1	15.0	155.0	155.0	75.0	14.00	0.15	0.15	17.082
10	23.2	15.0	154.0	154.0	75.0	14.10	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*/T**44	MP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MAG
1	0.0	0.3515	0.8656	0.4061	0.0	0.323	0.0	302.25	100.75	100.75	0.083
2	0.1874	0.2590	0.8670	0.2987	0.1760	0.324	0.061	301.34	116.91	100.44	0.083
3	0.3494	0.1795	0.8684	0.2071	0.3284	0.325	0.113	300.47	131.04	100.15	0.082
4	0.4868	0.1110	0.8684	0.1279	0.4575	0.325	0.158	300.03	143.16	100.00	0.082
5	0.6233	0.0459	0.8698	0.0528	0.5863	0.326	0.203	299.38	155.26	99.79	0.082
6	0.6709	0.0227	0.8698	0.0261	0.6310	0.326	0.219	299.20	155.47	99.73	0.082
7	0.6898	0.0121	0.8698	0.0139	0.6488	0.326	0.225	299.16	161.16	99.72	0.082
8	0.6840	0.0091	0.8698	0.0105	0.6433	0.326	0.223	299.13	160.63	99.70	0.082
9	0.6875	0.0076	0.8698	0.0087	0.6466	0.326	0.224	299.16	160.97	99.71	0.082
10	*****	0.0	0.8713	0.0	*****	0.326	*****	298.88	*****	99.62	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(d) S/D = -0.24, $M_u = 0.082$

Table XI. Continued.

DATA TAKEN 8 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.24

1/1/4.57/-024/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AH/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.84 INCHES HG

N RUN	FOR (INCHES OF WATER)	OPUR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMD	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	10.9	10.0	153.0	153.0	75.0	4.90	4.66	4.66	0.0
2	12.2	10.0	153.0	153.0	75.0	6.10	3.46	3.46	0.785
3	13.2	10.0	153.0	153.0	75.0	7.20	2.35	2.35	1.767
4	14.1	10.0	154.0	154.0	75.0	8.00	1.48	1.48	3.142
5	14.8	10.0	154.0	154.0	75.0	8.80	0.61	0.61	4.284
6	15.3	10.0	154.0	154.0	75.0	9.20	0.30	0.30	9.621
7	15.3	10.0	154.0	154.0	75.0	9.30	0.15	0.15	13.540
8	15.3	10.0	154.0	154.0	75.0	9.30	0.12	0.12	15.512
9	15.3	10.0	154.0	154.0	75.0	9.30	0.10	0.10	17.082
10	15.5	10.0	153.0	153.0	75.0	9.40	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*1**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MAC+
1	0.0	0.3458	0.8727	0.3963	0.0	0.264	0.0	246.87	82.28	82.28	0.068
2	0.1870	0.2575	0.8727	0.2951	0.1762	0.264	0.043	246.53	95.60	82.17	0.068
3	0.3466	0.1754	0.8727	0.2010	0.3264	0.265	0.092	246.17	107.02	82.05	0.068
4	0.4889	0.1105	0.8713	0.1268	0.4602	0.265	0.129	246.16	117.33	82.05	0.068
5	0.6273	0.0455	0.8713	0.0524	0.5904	0.265	0.166	245.89	127.31	81.96	0.067
6	0.6731	0.0225	0.8713	0.0258	0.6335	0.265	0.178	245.79	130.64	81.93	0.067
7	0.6702	0.0112	0.8713	0.0129	0.6308	0.265	0.178	245.74	130.42	81.91	0.067
8	0.6864	0.0090	0.8713	0.0103	0.6460	0.265	0.182	245.74	131.59	81.91	0.067
9	0.6900	0.0075	0.8713	0.0086	0.6494	0.265	0.183	245.74	131.85	81.91	0.067
10	*****	0.0	0.8727	0.0	*****	0.265	*****	245.53	*****	81.84	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0
PHS (IN. H2O):	-1.25	-1.17	-0.71	-0.65	-0.47	-0.30	-0.10
PHS*:	-0.10	-0.09	-0.05	-0.05	-0.04	-0.02	-0.01

(e) S/D = -0.24, $M_u = 0.068$

Table XI. Continued.

DATA TAKEN 8 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STAMPOFF -0.24

1/1/4.57/-024/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, A/A_P: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.84 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UN (FT/SEC)	UU (FT/SEC)	UPT MACH
1	5.6	5.0	149.0	149.0	75.0	2.50	2.34	2.34	0.0	58.30	58.30	0.048
2	6.1	5.0	149.0	149.0	75.0	3.10	1.74	1.74	0.785	67.77	58.25	0.048
3	6.7	5.0	149.0	149.0	75.0	3.60	1.21	1.21	1.767	76.13	58.22	0.048
4	7.1	5.0	150.0	150.0	75.0	4.00	0.74	0.74	3.142	83.17	58.24	0.048
5	7.5	5.0	150.0	150.0	75.0	4.40	0.30	0.30	6.284	89.89	58.21	0.048
6	7.6	5.0	150.0	150.0	75.0	4.60	0.15	0.15	9.621	92.03	58.19	0.048
7	7.7	5.0	150.0	150.0	75.0	4.60	0.08	0.08	13.548	93.60	58.20	0.048
8	7.7	5.0	150.0	150.0	75.0	4.60	0.06	0.06	15.512	93.30	58.20	0.048
9	7.7	5.0	150.0	150.0	75.0	4.60	0.05	0.05	17.082	93.49	58.20	0.048
10	7.7	5.0	151.0	151.0	75.0	4.60	0.0	0.0	*****	*****	58.24	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0
PMS (IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS*:	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(f) S/D = -0.24, M_u = 0.048

Table XI. Continued.

DATA TAKEN 11 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/4.57/ 084/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 13.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES
AREA RATIO, AM/AP: 3.00
ORIFICE DIAMETER: 2.154 INCHES
ORIFICE BETA: 0.70
AMBIENT PRESSURE: 29.77 INCHES HG

N RUN	POR (INCHES OF WATER)	OPGR (INCHES OF WATER)	TOR (DEGREES FAIRPENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	16.7	15.0	150.0	150.0	73.0	7.70	6.80	6.80	0.0
2	18.5	15.0	150.0	150.0	73.0	9.50	4.89	4.89	0.785
3	19.8	15.0	150.0	150.0	73.0	10.80	3.18	3.18	1.767
4	20.7	15.0	149.0	149.0	73.0	11.70	1.85	1.85	3.142
5	21.4	15.0	149.0	149.0	73.0	12.40	0.70	0.70	6.284
6	21.6	15.0	149.0	149.0	73.0	12.60	0.33	0.33	9.621
7	21.6	15.0	149.0	149.0	73.0	12.60	0.17	0.17	13.548
8	21.7	15.0	149.0	149.0	73.0	12.70	0.13	0.13	15.512
9	21.7	15.0	149.0	149.0	73.0	12.70	0.11	0.11	17.082
10	21.7	15.0	148.0	148.0	73.0	12.80	0.9	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*1**44	WIP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3400	0.8737	0.3891	0.0	0.324	0.0	300.57	100.18	100.18	0.083
2	0.1809	0.2456	0.8737	0.2811	0.1705	0.325	0.059	299.90	115.95	99.96	0.083
3	0.3280	0.1602	0.8737	0.1834	0.3090	0.326	0.107	299.42	128.88	55.80	0.082
4	0.4440	0.0936	0.8751	0.1069	0.4187	0.326	0.145	298.85	139.10	99.61	0.082
5	0.5457	0.0355	0.8751	0.0405	0.5146	0.327	0.178	298.59	148.15	99.52	0.082
6	0.5735	0.0167	0.8751	0.0191	0.5409	0.327	0.187	298.52	150.63	99.50	0.082
7	0.5797	0.0086	0.8751	0.0098	0.5466	0.327	0.189	298.52	151.18	99.50	0.082
8	0.5803	0.0066	0.8751	0.0075	0.5473	0.327	0.190	298.48	151.23	99.49	0.082
9	0.5879	0.0056	0.8751	0.0064	0.5544	0.327	0.192	298.48	151.90	99.49	0.082
10	*****	0.0	0.8766	0.0	*****	0.327	*****	298.16	*****	99.38	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0
PMS(IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS%:	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(g) S/D = -0.84, $M_u = 0.082$

Table XI. Continued.

DATA TAKEN 11 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84 1/1/4.57/ 084/10

UP TAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.77 INCHES HG

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

N RUN	PUR (INCHES OF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAHR	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UU (FT/SEC)	UM (FT/SEC)	UP (FT/SEC)	WS (LBM/SEC)	WP (LBM/SEC)	WPT**44	P*/T*	Y*	W*	N
1	11.2	10.0	148.0	148.0	73.0	5.10	4.50	4.50	0.0	82.03	82.03	246.11	0.0	0.265	0.0	0.3828	0.8756	0.3355	0.0
2	12.3	10.0	148.0	148.0	73.0	6.20	3.28	3.28	0.785	81.92	95.00	245.78	0.048	0.265	0.1715	0.2798	0.8756	0.2452	0.1817
3	13.2	10.0	148.0	148.0	73.0	7.20	2.11	2.11	1.767	81.81	105.47	245.45	0.087	0.266	0.3092	0.1805	0.8766	0.1582	0.3277
4	13.7	10.0	148.0	148.0	73.0	7.70	1.24	1.24	3.142	81.76	114.05	245.30	0.119	0.266	0.4212	0.1062	0.8766	0.0931	0.4464
5	14.2	10.0	148.0	148.0	73.0	9.10	0.48	0.48	6.284	81.73	121.73	245.21	0.147	0.266	0.5211	0.0407	0.8766	0.0357	0.5522
6	14.3	10.0	148.0	148.0	73.0	8.30	0.22	0.22	9.621	81.70	122.91	245.12	0.151	0.266	0.5367	0.0184	0.8766	0.0162	0.5687
7	14.3	10.0	148.0	148.0	73.0	8.30	0.12	0.12	13.548	81.70	124.15	245.12	0.156	0.266	0.5527	0.0059	0.8766	0.0086	0.5857
8	14.3	10.0	148.0	148.0	73.0	8.30	0.09	0.09	15.512	81.70	123.48	245.12	0.153	0.266	0.5441	0.0073	0.8766	0.0064	0.5766
9	14.4	10.0	148.0	148.0	73.0	8.40	0.07	0.07	17.082	81.69	123.45	245.09	0.153	0.266	0.5437	0.0060	0.8756	0.0053	0.5761
10	14.4	10.0	144.0	144.0	73.0	8.40	0.0	0.0	*****	81.42	*****	244.28	*****	0.267	*****	0.0	0.8824	0.0	*****

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0
PMS (IN. H2O):	-1.27	-1.08	-0.83	-0.81	-0.61	-0.34	-0.13
PMS*:	-0.10	-0.08	-0.06	-0.06	-0.05	-0.03	-0.01

(h) S/D = -0.84, $M_u = 0.068$

Table XI. Continued.

DATA TAKEN 11 JULY 77 BY PETE HARRELL

ONE NOZZLE, ELLIPTIC TRANSITION, STANDOFF -0.84

1/1/4-57/ 084/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AH/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.77 INCHES HG

N RUN	POR (INCHES OF WATER)	DPUR	TOR	TUPT (DEGREES FAHRENHEIT)	IAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)
1	5.6	5.0	144.0	144.0	73.0	2.50	2.23	2.23	0.0
2	6.2	5.0	144.0	144.0	73.0	3.10	1.66	1.66	0.785
3	6.6	5.0	144.0	144.0	73.0	3.60	1.08	1.08	1.767
4	6.9	5.0	144.0	144.0	73.0	3.80	0.62	0.62	3.142
5	7.1	5.0	144.0	144.0	73.0	4.00	0.23	0.23	6.284
6	7.2	5.0	144.0	144.0	73.0	4.10	0.11	0.11	9.621
7	7.2	5.0	144.0	144.0	73.0	4.10	0.05	0.05	13.548
8	7.2	5.0	145.0	145.0	73.0	4.20	0.04	0.04	15.512
9	7.3	5.0	145.0	145.0	73.0	4.20	0.03	0.03	17.082
10	7.4	5.0	143.0	143.0	73.0	4.20	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*F**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UN (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3312	0.8824	0.3753	0.0	0.188	0.0	174.39	58.13	58.13	0.048
2	0.1825	0.2469	0.8824	0.2798	0.1727	0.188	0.034	174.26	67.39	58.08	0.048
3	0.3311	0.1609	0.8824	0.1823	0.3134	0.188	0.062	174.13	74.56	58.04	0.048
4	0.4460	0.0924	0.8824	0.1047	0.4221	0.188	0.084	174.11	80.85	58.03	0.048
5	0.5372	0.0335	0.8824	0.0380	0.5084	0.188	0.101	174.07	85.53	58.02	0.048
6	0.5618	0.0157	0.8824	0.0177	0.5317	0.188	0.106	174.05	86.80	58.01	0.048
7	0.5725	0.0082	0.8824	0.0093	0.5419	0.188	0.108	174.05	87.35	58.01	0.048
8	0.5595	0.0060	0.8809	0.0068	0.5291	0.188	0.105	174.15	86.68	58.05	0.048
9	0.5763	0.0052	0.8809	0.0059	0.5450	0.188	0.108	174.17	87.55	58.05	0.048
10	*****	0.0	0.8839	0.0	*****	0.188	*****	173.90	*****	57.96	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0
 PMS (IN. H2O): 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 PMS*: 0.0 0.0 0.0 0.0 0.0 0.0 0.0

(i) S/D = -0.84, $M_u = 0.048$

Table XI. Continued.

DATA TAKEN 14 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 1.00

1/0/3/100/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPI	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	16.7	15.0	152.0	152.0	74.0	7.70	7.05	7.05	0.0
2	18.5	15.0	152.0	152.0	74.0	9.50	5.13	5.13	0.785
3	20.1	15.0	153.0	153.0	74.0	11.20	3.45	3.45	1.767
4	21.5	15.0	153.0	153.0	74.0	12.50	2.10	2.10	3.142
5	23.0	15.0	153.0	153.0	74.0	14.00	0.83	0.83	6.284
6	23.3	15.0	153.0	153.0	74.0	14.30	0.40	0.40	9.621
7	23.4	15.0	153.0	153.0	74.0	14.40	0.21	0.21	13.548
8	23.4	15.0	153.0	153.0	74.0	14.50	0.16	0.16	15.512
9	23.5	15.0	153.0	153.0	74.0	14.50	0.14	0.14	17.082
10	23.7	15.0	152.0	151.0	74.0	14.70	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*F**44	HP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UP1 MAC-I
1	0.0	0.3520	0.8725	0.4034	0.0	0.324	0.0	300.91	100.30	100.30	0.081
2	0.1855	0.2573	0.8725	0.2949	0.1747	0.325	0.060	300.24	116.45	100.08	0.083
3	0.3420	0.1735	0.8711	0.1992	0.3218	0.325	0.111	299.83	130.23	99.94	0.082
4	0.4737	0.1059	0.8711	0.1216	0.4458	0.326	0.154	299.38	141.87	99.79	0.082
5	0.5945	0.0420	0.8711	0.0482	0.5595	0.326	0.194	298.84	152.59	99.61	0.082
6	0.6317	0.0203	0.8711	0.0233	0.5945	0.326	0.206	298.73	155.90	99.57	0.082
7	0.6444	0.0106	0.8711	0.0122	0.6065	0.326	0.210	298.69	157.03	99.56	0.082
8	0.6441	0.0081	0.8711	0.0093	0.6061	0.326	0.210	298.62	156.98	99.53	0.082
9	0.6634	0.0071	0.8711	0.0081	0.6243	0.326	0.217	298.66	158.72	99.55	0.082
10	*****	0.0	0.8739	0.0	*****	0.327	*****	297.85	*****	99.28	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5

PMS(LIN. H2O): 0.0 0.0 0.0 0.0 0.0

PMS*: 0.0 0.0 0.0 0.0 0.0

(a) S/D = 1.0, $M_u = 0.082$

Table XII. Single-Nozzle Performance Data for L/D = 3.0,
 Straight Entrance.

DATA TAKEN 14 JULY 77 BY PETE HARRELL

CHE NOZZLE, NO TRANSITION, STANDOFF 1.00

1/0/3/100/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.80 INCHES HG

N	POR	DPUR	TOR	TUPT	TAMB	PJ-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)	(INCHES OF WATER)		(SQUARE INCHES)
1	11.1	10.0	151.0	151.0	74.0	5.00	4.65	4.65	0.0
2	12.3	10.0	152.0	152.0	74.0	6.30	3.40	3.40	0.785
3	13.4	10.0	152.0	152.0	74.0	7.40	2.28	2.28	1.767
4	14.3	10.0	152.0	152.0	74.0	8.30	1.41	1.41	3.142
5	15.2	10.0	152.0	152.0	74.0	9.20	0.54	0.54	6.284
6	15.4	10.0	153.0	153.0	74.0	9.40	0.26	0.26	9.621
7	15.6	10.0	153.0	153.0	74.0	9.60	0.14	0.14	13.548
8	15.6	10.0	153.0	153.0	74.0	9.60	0.11	0.11	15.512
9	15.6	10.0	153.0	153.0	74.0	9.60	0.09	0.09	17.082
10	15.7	10.0	149.0	149.0	74.0	9.70	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UM	UU	UPT
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	MACH
1	0.0	0.3456	0.8739	0.3955	0.0	0.264	0.0	246.63	82.20	82.20	0.068
2	0.1854	0.2531	0.8725	0.2501	0.1746	0.264	0.049	246.40	95.44	82.13	0.068
3	0.3413	0.1702	0.8725	0.1951	0.3214	0.265	0.090	246.07	106.61	82.02	0.068
4	0.4768	0.1055	0.8725	0.1209	0.4490	0.265	0.126	245.80	116.36	81.93	0.068
5	0.5895	0.0405	0.8725	0.0464	0.5551	0.265	0.156	245.53	124.51	81.84	0.068
6	0.6205	0.0191	0.8711	0.0219	0.5840	0.265	0.165	245.67	126.77	81.88	0.067
7	0.6357	0.0101	0.8711	0.0116	0.5582	0.265	0.169	245.61	127.87	81.86	0.067
8	0.6419	0.0079	0.8711	0.0090	0.6040	0.265	0.170	245.61	128.32	81.86	0.067
9	0.6360	0.0064	0.8711	0.0073	0.5985	0.265	0.169	245.61	127.89	81.86	0.067
10	*****	0.0	0.8768	0.0	*****	0.266	*****	244.78	*****	81.59	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5
 PMS(IN. H2O): -1.41 -0.89 -0.63 -0.36 -0.14
 PMS*: -0.11 -0.07 -0.05 0.03 0.01

(b) S/D = 1.0, $M_u = 0.068$
 Table XII. Continued.

DATA TAKEN 14 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 1.00

170/3/100/05

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 9.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	POR (INCHES OF WATER)	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA	PA-PS (INCHES OF WATER)*	PA-PNZ	SECONDARY AREA (SQUARE INCHES)
1	5.6	5.0	147.0	75.0	2.50	2.30	2.30	0.0
2	6.1	5.0	147.0	75.0	3.10	1.69	1.69	0.785
3	6.8	5.0	147.0	75.0	3.70	1.18	1.18	1.767
4	7.1	5.0	147.0	75.0	4.10	0.70	0.70	3.142
5	7.7	5.0	148.0	75.0	4.60	0.27	0.27	6.284
6	7.8	5.0	147.0	75.0	4.70	0.13	0.13	9.621
7	7.9	5.0	148.0	75.0	4.80	0.07	0.07	13.548
8	7.9	5.0	148.0	75.0	4.80	0.05	0.05	15.512
9	8.0	5.0	149.0	75.0	4.80	0.05	0.05	17.082
10	8.0	5.0	147.0	75.0	4.90	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W+T**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UH (FT/SEC)	UU (FT/SEC)	UPT HACH
1	0.0	0.3412	0.8813	0.3871	0.0	0.187	0.0	174.74	58.24	58.24	0.048
2	0.1842	0.2511	0.8813	0.2845	0.1743	0.187	0.035	174.55	67.55	58.19	0.048
3	0.3463	0.1756	0.8813	0.1992	0.3275	0.188	0.065	174.48	75.87	58.16	0.048
4	0.4740	0.1043	0.8813	0.1183	0.4484	0.188	0.089	174.37	82.40	58.12	0.048
5	0.5889	0.0402	0.8799	0.0457	0.5566	0.188	0.111	174.43	88.32	58.14	0.048
6	0.6250	0.0194	0.8813	0.0220	0.5912	0.188	0.117	174.26	90.17	58.08	0.048
7	0.6463	0.0104	0.8799	0.0118	0.6109	0.188	0.121	174.39	91.27	58.12	0.048
8	0.6559	0.0082	0.8799	0.0093	0.6200	0.188	0.123	174.39	91.77	58.12	0.048
9	0.6892	0.0074	0.8784	0.0085	0.6510	0.188	0.129	174.55	93.50	58.18	0.048
10	*****	0.0	0.8813	0.0	*****	0.188	*****	174.22	*****	58.07	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5
PMS(IN. H2O): 0.0 0.0 0.0 0.0 0.0
PMS*: 0.0 0.0 0.0 0.0 0.0

(c) S/D = 1.0, $M_u = 0.048$

Table XII. Continued.

DATA TAKEN 14 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.75

1/0/3/075/15

NUMBER OF PRIMARY NOZZLES: 1
PRIMARY NOZZLE DIAMETER: 1.732 INCHES
MIXING STACK LENGTH: 9.00 INCHES
MIXING STACK DIAMETER: 3.00 INCHES
MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
AREA RATIO, AM/AP: 3.00
ORIFICE DIAMETER: 2.154 INCHES
ORIFICE BETA: 0.70
AMBIENT PRESSURE: 29.80 INCHES HG

N	POR	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA			
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)	(INCHES OF WATER)		(SQUARE INCHES)			
1	16.8	15.0	154.0	154.0	75.0	7.80	7.00	7.00	0.0			
2	18.6	15.0	154.0	154.0	75.0	9.60	5.00	5.00	0.785			
3	20.3	15.0	155.0	155.0	75.0	11.30	3.40	3.40	1.767			
4	21.7	15.0	155.0	155.0	75.0	12.60	2.06	2.06	3.142			
5	22.8	15.0	155.0	155.0	75.0	13.80	0.80	0.80	6.284			
6	23.3	15.0	156.0	156.0	75.0	14.30	0.40	0.40	9.621			
7	23.4	15.0	156.0	156.0	75.0	14.40	0.23	0.23	13.548			
8	23.5	15.0	156.0	156.0	75.0	14.50	0.17	0.17	15.512			
9	23.5	15.0	156.0	156.0	75.0	14.50	0.15	0.15	17.082			
10	23.7	15.0	152.0	152.0	75.0	14.70	0.0	0.0	*****			
N	W*	P*	T*	P*/T*	W*/T**44	WP	WS	UP	UM	UU	UPT	MACH
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)		
1	0.0	0.3491	0.8713	0.4007	0.0	0.324	0.0	301.37	100.45	100.45	0.083	
2	0.1832	0.2504	0.8713	0.2875	0.1724	0.324	0.059	300.70	116.40	100.23	0.083	
3	0.3397	0.1707	0.8698	0.1963	0.3195	0.325	0.110	300.31	130.19	100.10	0.082	
4	0.4694	0.1038	0.8698	0.1193	0.4414	0.325	0.153	299.87	141.66	99.95	0.082	
5	0.5842	0.0404	0.8698	0.0465	0.5495	0.326	0.190	299.40	151.84	99.79	0.082	
6	0.6326	0.0202	0.8684	0.0233	0.5946	0.326	0.206	299.46	156.17	95.81	0.082	
7	0.6681	0.0114	0.8684	0.0131	0.6279	0.326	0.218	299.42	159.33	99.80	0.082	
8	0.6648	0.0086	0.8684	0.0099	0.6248	0.326	0.216	299.39	159.04	99.79	0.082	
9	0.6761	0.0073	0.8684	0.0084	0.6354	0.326	0.220	299.39	160.05	99.79	0.082	
10	*****	0.0	0.8741	0.0	*****	0.327	*****	298.34	*****	99.44	0.082	

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5
PMS(IN. H2O): 0.0 0.0 0.0 0.0 0.0
PMS*: 0.0 0.0 0.0 0.0 0.0

(d) S/D = 0.75, $M_u = 0.082$
Table XII. Continued.

DATA TAKEN 14 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.75

1/0/3/075/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	WS (LBM/SEC)	UP (FT/SEC)	UU (FT/SEC)	UPT MACH
1	11.1	10.0	152.0	152.0	75.0	5.10	4.59	4.59	0.0	0.264	246.77	82.25	0.068
2	12.4	10.0	152.0	152.0	75.0	6.30	3.35	3.35	0.785	0.265	246.43	82.14	0.068
3	13.5	10.0	152.0	152.0	75.0	7.50	2.25	2.25	1.767	0.265	246.04	82.01	0.068
4	14.3	10.0	152.0	152.0	75.0	8.30	1.37	1.37	3.142	0.265	245.80	81.93	0.068
5	15.2	10.0	152.0	152.0	75.0	9.10	0.52	0.52	6.284	0.265	245.59	81.86	0.068
6	15.6	10.0	152.0	152.0	75.0	9.50	0.25	0.25	9.621	0.266	245.47	81.82	0.067
7	15.7	10.0	151.0	151.0	75.0	9.70	0.13	0.13	13.548	0.266	245.18	81.72	0.067
8	15.7	10.0	151.0	151.0	75.0	9.60	0.10	0.10	15.512	0.266	245.24	81.74	0.067
9	15.7	10.0	150.0	150.0	75.0	9.60	0.08	0.08	17.082	0.266	245.04	81.67	0.067
10	15.7	10.0	148.0	148.0	75.0	9.70	0.0	0.0	*****	0.266	244.57	81.52	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5
 PHS(IN. H2O): -1.64 -1.13 -0.73 -0.39 -0.15
 PHS*: -0.12 -0.09 -0.05 -0.03 -0.01

(e) S/D = 0.75, $M_u = 0.068$

Table XII. Continued.

DATA TAKEN 14 JULY 77 BY PFIE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.75

1/0/3/075/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

N RUN	POR (INCHES OF WATER)	DPOR (INCHES OF WATER)	TWR (DEGREES FAHRENHEIT)	TUPT (DEGREES FAHRENHEIT)	TANB	PJ-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UPTAKE DIAMETER: 3.00 INCHES AREA RATIO, AM/AP: 3.00 ORIFICE DIAMETER: 2.154 INCHES ORIFICE BETA: 0.70 AMBIENT PRESSURE: 29.80 INCHES Hg			
1	5.6	5.0	149.0	149.0	75.0	2.50	2.29	2.29	0.0				
2	6.2	5.0	149.0	149.0	75.0	3.10	1.69	1.69	0.785				
3	6.8	5.0	149.0	149.0	75.0	3.70	1.14	1.14	1.767				
4	7.3	5.0	150.0	150.0	75.0	4.20	0.69	0.69	3.142				
5	7.7	5.0	150.0	150.0	75.0	4.60	0.26	0.26	6.284				
6	7.8	5.0	150.0	150.0	75.0	4.70	0.13	0.13	5.621				
7	7.8	5.0	150.0	150.0	75.0	4.80	0.07	0.07	13.548				
8	7.9	5.0	151.0	151.0	75.0	4.80	0.05	0.05	15.512				
9	7.9	5.0	151.0	151.0	75.0	4.80	0.05	0.05	17.082				
10	8.0	5.0	149.0	149.0	75.0	4.90	0.0	0.0	*****				
N RUN	W*	P*	T*	P*/T*	WE/T**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UH (FT/SEC)	UU (FT/SEC)	IPT MAC+		
1	0.0	0.3386	0.8784	0.3854	0.0	0.187	0.0	175.02	58.34	58.34			0.048
2	0.1845	0.2502	0.8704	0.2849	0.1743	0.187	0.035	174.89	67.68	58.29			0.048
3	0.3409	0.1690	0.8784	0.1924	0.3220	0.187	0.064	174.76	75.65	58.25			0.048
4	0.4700	0.1015	0.8770	0.1158	0.4436	0.187	0.088	174.80	82.26	58.26			0.048
5	0.5788	0.0386	0.8770	0.0440	0.5463	0.187	0.108	174.71	87.84	58.23			0.048
6	0.6144	0.0186	0.8770	0.0212	0.5799	0.187	0.115	174.69	89.66	58.23			0.048
7	0.6474	0.0104	0.8770	0.0119	0.6111	0.187	0.121	174.65	91.35	58.21			0.048
8	0.6575	0.0082	0.8755	0.0093	0.6202	0.187	0.123	174.82	91.89	58.27			0.048
9	0.6904	0.0074	0.8755	0.0085	0.6512	0.187	0.129	174.82	93.57	58.27			0.048
10	*****	0.0	0.8784	0.0	*****	0.188	*****	174.51	*****	58.17			0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5

PMS(IN. H2O): 0.0 0.0 0.0 0.0 0.0

PMS*: 0.0 0.0 0.0 0.0 0.0

(f) S/D = 0.75, $M_u = 0.048$

Table XII. Continued.

DATA TAKEN 15 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 1.50

1.0/3/050/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.77 INCHES HG

N	POF	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(SQUARE INCHES)					
1	18.9	15.0	150.0	150.0	71.0	7.50	6.82	6.82	0.0
2	18.7	15.0	150.0	150.0	71.0	9.70	4.88	4.08	0.785
3	20.4	15.0	150.0	150.0	71.0	11.50	3.27	3.27	1.767
4	21.7	15.0	150.0	150.0	71.0	12.70	1.94	1.94	3.142
5	22.9	15.0	150.0	150.0	71.0	13.90	0.74	0.74	6.284
6	23.3	15.0	148.0	148.0	71.0	14.30	0.35	0.35	9.621
7	23.4	15.0	148.0	148.0	71.0	14.50	0.18	0.18	13.548
8	23.4	15.0	148.0	148.0	71.0	14.50	0.14	0.14	15.512
9	23.5	15.0	150.0	150.0	71.0	14.50	0.11	0.11	17.082
10	23.6	15.0	146.0	146.0	71.0	14.70	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W* T**44	WP	WS	UP	UM	UU	UPT MAGN
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	
1	0.0	0.3399	0.8704	0.3904	0.0	0.325	0.0	300.50	100.16	100.16	0.083
2	0.1811	0.2443	0.8704	0.2806	0.1703	0.325	0.059	299.83	115.86	99.94	0.083
3	0.3330	0.1644	0.8704	0.1889	0.3132	0.326	0.109	299.13	129.17	99.70	0.082
4	0.4553	0.0978	0.8704	0.1124	0.4284	0.326	0.149	298.73	139.92	99.57	0.082
5	0.5597	0.0372	0.8704	0.0427	0.5766	0.327	0.183	298.29	149.14	99.42	0.082
6	0.5859	0.0175	0.8733	0.0201	0.5520	0.328	0.192	297.65	151.41	99.21	0.082
7	0.5959	0.0091	0.8733	0.0105	0.5614	0.328	0.195	297.55	152.27	99.18	0.082
8	0.5908	0.0069	0.8733	0.0079	0.5566	0.328	0.194	297.55	151.83	99.18	0.082
9	0.5882	0.0056	0.8704	0.0044	0.5534	0.327	0.192	298.07	151.66	99.35	0.082
10	*****	0.0	0.8762	.	*****	0.320	*****	296.98	*****	98.99	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5
 PMS(IN. H2O): 0.0 0.0 0.0 0.0 0.0
 PMS*: 0.0 0.0 0.0 0.0 0.0

(g) S/D = 0.50, $M_u = 0.082$
 Table XII. Continued

DATA TAKEN 15 JULY 77 BY PFTT HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.50

1/0/3/050/10

NUMBER OF PRIMARY NOZZLES: 1
PRIMARY NOZZLE DIAMETER: 1.732 INCHES
MIXING STACK LENGTH: 9.00 INCHES
MIXING STACK DIAMETER: 3.00 INCHES
MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
AREA RATIO, AM/AP: 3.00
ORIFICE DIAMETER: 2.154 INCHES
ORIFICE BETA: 0.70
AMBIENT PRESSURE: 29.77 INCHES HG

N	POR	OPUR	TOR	TUPT	TAMB	PIJ-PA	PA-PS	PA-PN2	SECONDARY AREA	UPT	MAC-I
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)			
1	11.2	10.0	149.0	149.0	71.0	5.20	4.54	4.54	0.0		
2	12.5	10.0	147.0	147.0	71.0	6.40	3.31	3.31	0.785		
3	13.6	10.0	146.0	146.0	71.0	7.50	2.10	2.10	1.767		
4	14.4	10.0	146.0	146.0	71.0	8.40	1.32	1.32	3.142		
5	15.2	10.0	146.0	146.0	71.0	9.10	0.52	0.52	6.284		
6	15.4	10.0	146.0	146.0	71.0	9.40	0.26	0.26	9.621		
7	15.5	10.0	146.0	146.0	71.0	9.50	0.15	0.15	13.548		
8	15.5	10.0	146.0	146.0	71.0	9.50	0.11	0.11	15.512		
9	15.6	10.0	146.0	146.0	71.0	9.50	0.09	0.09	17.082		
10	15.6	10.0	144.0	144.0	71.0	9.60	0.0	0.0	*****		
N	W*	P*	T*	P*/1*	WAT*	WP	WS	UP	UM	UW	UPT
MAC-I						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	
1	0.0	0.3369	0.8719	0.3864	0.0	0.245	0.0	246.26	82.08	82.08	0.068
2	0.1827	0.2471	0.8747	0.2825	0.1722	0.266	0.048	245.52	94.94	81.83	0.068
3	0.3330	0.1634	0.8762	0.1865	0.3142	0.266	0.089	244.98	105.66	81.66	0.068
4	0.4603	0.0992	0.8762	0.1132	0.4343	0.266	0.123	244.68	114.82	81.56	0.068
5	0.5744	0.0388	0.8762	0.0442	0.5420	0.267	0.153	244.50	123.09	81.50	0.068
6	0.6248	0.0196	0.8762	0.0224	0.5895	0.267	0.167	244.38	126.72	81.45	0.068
7	0.6569	0.0109	0.8762	0.0125	0.6190	0.267	0.175	244.35	129.04	81.45	0.068
8	0.6551	0.0083	0.8762	0.0095	0.6181	0.267	0.175	244.35	128.93	81.45	0.068
9	0.6525	0.0068	0.8762	0.0077	0.6156	0.267	0.174	244.38	128.75	81.46	0.068
10	*****	0.0	0.8791	0.0	*****	0.267	*****	243.92	*****	81.30	0.068

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5
PHS(IN, H2O): -1.81 -1.37 -0.90 -0.49 -0.20
PHS*: -0.14 -0.10 -0.07 -0.04 -0.01

(h) S/D = 0.50, $M_u = 0.068$
Table XII. Continued.

50/050/E/0/1

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 9.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFILE BETA: 0.70

AMBIENT PRESSURE: 29.77 INCHES HG

N RUN	POR (INCHES OF WATER)	DPUR	TOR	DUPT (DEGREES FAHRENHIT)	TAHB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)		
1	5.6	5.0	141.0	141.0	71.0	2.60	2.27	2.27	0.0		
2	6.3	5.0	141.0	141.0	71.0	3.20	1.66	1.66	0.785		
3	6.8	5.0	142.0	142.0	71.0	3.70	1.10	1.10	1.767		
4	7.2	5.0	142.0	142.0	71.0	4.10	0.65	0.65	3.142		
5	7.7	5.0	142.0	142.0	71.0	4.60	0.25	0.25	6.284		
6	7.8	5.0	143.0	143.0	71.0	4.70	0.12	0.12	9.621		
7	7.9	5.0	143.0	143.0	71.0	4.80	0.07	0.07	13.548		
8	7.9	5.0	144.0	144.0	71.0	4.80	0.05	0.05	15.512		
9	7.9	5.0	144.0	144.0	71.0	4.80	0.04	0.04	17.082		
10	7.9	5.0	142.0	142.0	71.0	4.80	0.0	0.0	*****		
N RUN	W*	P*	T*	P*/T*	W*T**44	W/P (LUM/SEC)	WS (LUM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3377	0.8835	0.3822	0.0	0.188	0.0	173.91	57.97	57.97	0.048
2	0.1823	0.2473	0.8835	0.2799	0.1727	0.188	0.034	173.81	67.22	57.93	0.048
3	0.3342	0.1638	0.8820	0.1857	0.3162	0.188	0.063	173.84	74.90	57.94	0.048
4	0.4548	0.0961	0.8820	0.1090	0.4304	0.188	0.086	173.76	81.15	57.92	0.048
5	0.5660	0.0373	0.8820	0.423	0.5355	0.189	0.107	173.65	86.84	57.88	0.048
6	0.6008	0.0179	0.8805	0.0203	0.5680	0.188	0.113	173.77	88.64	57.92	0.048
7	0.6225	0.0097	0.8805	0.0110	0.5886	0.188	0.117	173.75	89.75	57.91	0.048
8	0.6257	0.0074	0.8791	0.0085	0.5912	0.138	0.118	173.90	89.93	57.96	0.048
9	0.6536	0.0067	0.8791	0.0076	0.6176	0.184	0.123	173.90	91.36	57.96	0.048
10	*****	0.0	0.8820	0.0	*****	0.189	*****	173.61	*****	57.87	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

Normalized Maximum Strain (\$\epsilon/\epsilon_0\$)	Normalized Maximum Stress Ratio (\$\sigma_{max}/\sigma_{max0}\$)
0.0	1.00
0.5	0.65
0.8	0.40
1.0	0.45
1.5	0.55
2.0	0.58
2.5	0.60

PHS(1N-H2O): 0.0 0.0 0.0 0.0

PHS*: 0.0 0.0 0.0 0.0

(i) $S/D = 0.50$, $M_u = 0.048$

Table XII. Continued.

DATA TAKEN 15 JULY 77 BY PETE MARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.25

1/0/3/025/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 9.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.77 INCHES HG

N	POR	UPOR	TUR	TUPT	TAMB	P-U-PA	PA-PS	PA-PNZ	SECONDARY AREA	UPTAKE
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)	(INCHES)
1	17.1	15.0	149.0	149.0	72.0	8.10	6.68	6.68	0.0	0.0
2	18.9	15.0	149.0	149.0	72.0	9.90	4.70	4.70	0.785	0.785
3	20.5	15.0	149.0	149.0	72.0	11.50	2.98	2.98	1.767	1.767
4	21.8	15.0	149.0	149.0	72.0	12.70	1.75	1.75	3.142	3.142
5	22.6	15.0	150.0	150.0	72.0	13.60	0.64	0.64	6.284	6.284
6	23.0	15.0	150.0	150.0	72.0	14.00	0.30	0.30	9.621	9.621
7	23.2	15.0	150.0	150.0	72.0	14.20	0.16	0.16	13.548	13.548
8	23.2	15.0	150.0	150.0	72.0	14.20	0.12	0.12	15.512	15.512
9	23.2	15.0	150.0	150.0	72.0	14.20	0.10	0.10	17.082	17.082
10	23.3	15.0	148.0	148.0	72.0	14.30	0.0	0.0	*****	*****

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UM	UU	UPT
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	(INCHES)
1	0.0	0.3342	0.8735	0.3826	0.0	0.325	0.0	300.17	100.05	100.05	0.003
2	0.1773	0.2362	0.8735	0.2704	0.1671	0.326	0.058	299.51	115.49	99.83	0.003
3	0.3173	0.1504	0.8735	0.1721	0.2989	0.326	0.103	298.92	127.76	99.63	0.002
4	0.4316	0.0885	0.8735	0.1014	0.4067	0.327	0.141	298.52	137.87	99.50	0.002
5	0.5220	0.0324	0.8721	0.0372	0.4915	0.327	0.171	298.40	145.90	99.46	0.002
6	0.5469	0.0152	0.8721	0.0174	0.5149	0.327	0.179	298.25	148.11	99.41	0.002
7	0.5535	0.0079	0.8721	0.0090	0.5211	0.327	0.181	298.18	148.60	99.39	0.002
8	0.5458	0.0058	0.8721	0.0067	0.5139	0.327	0.178	298.18	148.00	99.39	0.002
9	0.5463	0.0048	0.8721	0.0055	0.5144	0.327	0.179	298.18	148.04	99.39	0.002
10	*****	0.0	0.8749	0.0	*****	0.328	*****	297.65	*****	99.21	0.002

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5

PMS(IN. H2O): 0.0 0.0 0.0 0.0 0.0

PMS*: 0.0 0.0 0.0 0.0 0.0

(j) S/D = 0.25, $M_u = 0.082$

Table XII. Continued.

DATA TAKEN 15 JULY 77 BY PETE HARRELL

CNE NOZZLE, NO TRANSITION, STANDOFF 0.25

1/0/3/025/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.77 INCHES HG

N RUN	POR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-P-S (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	5.6	144.0	144.0	73.0	2.60	2.20	2.20	0.0
2	6.4	144.0	144.0	73.0	3.30	1.61	1.61	0.785
3	6.9	144.0	144.0	73.0	3.80	1.03	1.03	1.767
4	7.3	144.0	144.0	73.0	4.20	0.59	0.59	3.142
5	7.6	145.0	145.0	73.0	4.50	0.22	0.22	6.284
6	7.7	145.0	145.0	73.0	4.60	0.10	0.10	9.621
7	7.7	145.0	145.0	73.0	4.70	0.05	0.05	13.548
8	7.8	145.0	145.0	73.0	4.70	0.04	0.04	15.512
9	7.8	145.0	145.0	73.0	4.70	0.04	0.04	17.082
10	7.8	145.0	145.0	73.0	4.70	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W* T** .44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3269	0.8824	0.3705	0.0	0.188	0.0	174.35	58.11	58.11	0.048
2	0.1797	0.2396	0.8824	0.2715	0.1700	0.188	0.034	174.22	67.23	58.07	0.048
3	0.3233	0.1535	0.8824	0.1739	0.3059	0.188	0.061	174.11	74.56	58.03	0.048
4	0.4330	0.0872	0.8824	0.0989	0.4098	0.188	0.081	174.03	80.17	58.01	0.048
5	0.5252	0.0320	0.8809	0.0364	0.4967	0.188	0.099	174.11	84.92	58.03	0.048
6	0.5484	0.0149	0.8809	0.0169	0.5186	0.188	0.103	174.08	86.41	58.02	0.048
7	0.5727	0.0082	0.8809	0.0093	0.5416	0.188	0.108	174.04	87.35	58.01	0.048
8	0.5930	0.0067	0.8809	0.0076	0.5608	0.188	0.112	174.06	88.40	58.02	0.048
9	0.6157	0.0060	0.8809	0.0068	0.5823	0.188	0.116	174.06	89.57	58.02	0.048
10	*****	0.0	0.8809	0.0	*****	0.188	*****	174.06	*****	58.02	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.5 1.0 1.5 2.0 2.5
 PMS(IN. H2O): 0.0 0.0 0.0 0.0 0.0
 PMS*: 0.0 0.0 0.0 0.0 0.0

(1) S/D = 0.25, $M_u = 0.048$
 Table XII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 1.00

1/0/2/100/15

NUMBER OF PRIMARY NOZZLES: 1
PRIMARY NOZZLE DIAMETER: 1.732 INCHES
MIXING STACK LENGTH: 6.00 INCHES
MIXING STACK DIAMETER: 3.00 INCHES
MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES
AREA RATIO, AM/AP: 3.00
ORIFICE DIAMETER: 2.154 INCHES
ORIFICE BETA: 0.70
AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	POR (INCHES OF WATER)	DPCR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA	PA-PS (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)
1	17.4	15.0	154.0	154.0	74.0	8.40	6.32	6.32	0.0
2	19.2	15.0	154.0	154.0	74.0	10.20	4.35	4.35	0.785
3	20.7	15.0	154.0	154.0	74.0	11.80	2.85	2.85	1.767
4	21.9	15.0	154.0	154.0	74.0	12.90	1.72	1.72	3.142
5	23.0	15.0	154.0	154.0	74.0	14.00	0.65	0.65	6.284
6	23.4	15.0	154.0	154.0	74.0	14.40	0.31	0.31	9.621
7	23.5	15.0	154.0	154.0	74.0	14.50	0.16	0.16	13.548
8	23.5	15.0	154.0	154.0	74.0	14.60	0.12	0.12	15.512
9	23.6	15.0	154.0	154.0	74.0	14.60	0.10	0.10	17.082
10	23.6	15.0	148.0	148.0	74.0	14.70	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W* T** .44	HP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3150	0.8696	0.3623	0.0	0.324	0.0	301.14	100.37	100.37	0.083
2	0.1709	0.2178	0.8696	0.2505	0.1607	0.325	0.055	300.47	115.22	100.15	0.082
3	0.3109	0.1433	0.8696	0.1648	0.2923	0.325	0.101	299.85	127.47	99.94	0.082
4	0.4288	0.0867	0.8696	0.0997	0.4033	0.326	0.140	299.48	137.89	99.82	0.082
5	0.5245	0.0326	0.8696	0.0375	0.4933	0.326	0.171	255.08	146.36	59.69	0.082
6	0.5520	0.0154	0.8696	0.0177	0.5191	0.326	0.180	298.94	148.79	99.64	0.082
7	0.5629	0.0081	0.8696	0.0093	0.5294	0.326	0.184	298.90	149.77	99.63	0.082
8	0.5582	0.0061	0.8696	0.0070	0.5249	0.326	0.182	298.83	149.32	59.60	0.082
9	0.5610	0.0051	0.8696	0.0058	0.5276	0.326	0.183	298.86	149.59	99.62	0.082
10	*****	0.0	0.8782	0.0	*****	0.328	*****	297.33	*****	99.10	0.082

(a) S/D = 1.0, $M_u = 0.082$

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8
PMS (IN. H2O): 0.0 0.0 0.0 0.0
PMS*: 0.0 0.0 0.0 0.0

Table XIII. Single-Nozzle Performance Data for L/D = 2.0, Straight Entrance.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 1.00

1/0/2/100/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	POR (INCHES OF WATER)	UPOR	YOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA	PA-PS (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)
1	11.5	10.0	150.0	150.0	74.0	5.50	4.20	4.20	0.0
2	12.8	10.0	151.0	151.0	74.0	6.70	2.93	2.93	0.785
3	13.7	10.0	152.0	152.0	74.0	7.70	1.94	1.94	1.767
4	14.6	10.0	152.0	152.0	74.0	8.50	1.18	1.18	3.142
5	15.2	10.0	152.0	152.0	74.0	9.20	0.44	0.44	6.284
6	15.4	10.0	152.0	152.0	74.0	9.40	0.22	0.22	9.621
7	15.6	10.0	152.0	152.0	74.0	9.50	0.12	0.12	13.548
8	15.6	10.0	152.0	152.0	74.0	9.60	0.09	0.09	15.512
9	15.6	10.0	152.0	152.0	74.0	9.60	0.07	0.07	17.082
10	15.7	10.0	146.0	146.0	74.0	9.60	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W* T** .44	MP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3131	0.8753	0.3577	0.0	0.265	0.0	246.24	82.08	82.08	0.068
2	0.1719	0.2187	0.8739	0.2502	0.1620	0.265	0.046	246.11	94.39	82.03	0.068
3	0.3147	0.1449	0.8725	0.1661	0.2964	0.265	0.083	245.98	104.67	81.99	0.068
4	0.4360	0.0883	0.8725	0.1012	0.4106	0.265	0.116	245.77	113.41	81.92	0.068
5	0.5291	0.0326	0.8725	0.0374	0.4982	0.265	0.140	245.53	120.12	81.84	0.068
6	0.5759	0.0165	0.8725	0.0189	0.5424	0.265	0.153	245.47	123.51	81.82	0.067
7	0.5988	0.0090	0.8725	0.0103	0.5639	0.266	0.159	245.47	125.19	81.82	0.067
8	0.5770	0.0064	0.8725	0.0073	0.5434	0.266	0.153	245.41	123.59	81.80	0.067
9	0.5766	0.0053	0.8725	0.0060	0.5431	0.266	0.153	245.41	123.56	81.80	0.067
10	*****	0.0	0.8811	0.0	*****	0.267	*****	244.23	*****	81.41	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8

PHS(IN. H2O): -1.39 -0.85 -0.43 -0.05

PHS*: +0.11 -0.06 -0.03 -0.01

(b) S/D = 1.0, $M_u = 0.068$
 Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 1.00

1/0/2/100/05

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 6.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.80 INCHES HG

N	POR	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA	UPT	MACH
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(SQ. INCHES)	(FT/SEC)	(FT/SEC)
1	5.7	5.0	148.0	148.0	74.0	2.70	2.13	2.13	0.0	58.27	0.048
2	6.4	5.0	148.0	148.0	74.0	3.30	1.50	1.50	0.785	58.23	0.048
3	6.9	5.0	148.0	148.0	74.0	3.80	0.98	0.98	1.767	58.20	0.048
4	7.4	5.0	147.0	147.0	74.0	4.30	0.59	0.59	3.142	58.11	0.048
5	7.7	5.0	147.0	147.0	74.0	4.60	0.22	0.22	6.284	58.09	0.048
6	7.8	5.0	147.0	147.0	74.0	4.70	0.10	0.10	9.621	58.08	0.048
7	7.8	5.0	147.0	147.0	74.0	4.80	0.05	0.05	13.548	58.07	0.048
8	7.8	5.0	147.0	147.0	74.0	4.80	0.03	0.03	15.512	58.07	0.048
9	7.9	5.0	146.0	146.0	74.0	4.80	0.03	0.03	17.082	58.03	0.048
10	7.9	5.0	145.0	145.0	74.0	4.80	0.0	0.0	*****	57.98	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.0

PMS(IN. H2O): 0.0 0.0 0.0 0.0

PMS*: 0.0 0.0 0.0 0.0

(c) S/D = 1.0, $M_u = 0.048$
Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.75

1/0/2/015/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	17.2	15.0	155.0	155.0	73.0	8.20	6.50	6.50	0.0
2	19.1	15.0	155.0	155.0	73.0	10.10	4.57	4.57	0.785
3	20.6	15.0	156.0	156.0	73.0	11.60	3.06	3.06	1.767
4	21.8	15.0	156.0	156.0	73.0	12.80	1.83	1.83	3.142
5	22.4	15.0	156.0	156.0	73.0	13.90	0.69	0.69	6.284
6	23.3	15.0	157.0	157.0	73.0	14.30	0.33	0.33	9.621
7	23.4	15.0	157.0	157.0	73.0	14.40	0.18	0.18	13.548
8	23.4	15.0	157.0	157.0	73.0	14.50	0.13	0.13	15.512
9	23.4	15.0	157.0	157.0	73.0	14.50	0.11	0.11	17.082
10	23.4	15.0	157.0	157.0	73.0	14.60	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*100.44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MAC-1
1	0.0	0.3227	0.8666	0.3724	0.0	0.323	0.0	301.46	100.48	100.48	0.083
2	0.1755	0.2280	0.8666	0.2631	0.1648	0.324	0.057	300.76	115.67	100.25	0.082
3	0.3230	0.1530	0.8652	0.1768	0.3031	0.325	0.105	300.45	128.61	100.14	0.082
4	0.4435	0.0917	0.8652	0.1060	0.4161	0.325	0.144	300.01	139.20	100.00	0.082
5	0.5440	0.0347	0.8652	0.0401	0.5104	0.325	0.177	299.60	148.06	99.86	0.082
6	0.5762	0.0166	0.8638	0.0192	0.5402	0.325	0.187	299.70	150.53	99.89	0.082
7	0.5908	0.0088	0.8638	0.0102	0.5539	0.325	0.192	299.67	152.22	99.88	0.082
8	0.5830	0.0065	0.8638	0.0076	0.5466	0.325	0.190	299.59	151.51	99.86	0.082
9	0.5905	0.0055	0.8638	0.0064	0.5537	0.325	0.192	299.59	152.18	99.86	0.082
10	*****	0.0	0.8638	0.0	*****	0.325	*****	299.59	*****	99.86	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8
 PMS(IN. H2O): 0.0 0.0 0.0 0.0
 PMS*: 0.0 0.0 0.0 0.0

(d) S/D = 0.75, $M_u = 0.082$
 Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

UNE NOZZLE, NO TRANSITION, STANDOFF 0.75

1/0/2/075/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AN/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.80 INCHES HG

N	POR	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA	UPTAKE	UU	UPT
KUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)	(FT/SEC)	(FT/SEC)	(FT/SEC)
1	11.3	10.0	154.0	154.0	73.0	5.30	4.29	4.29	0.0	82.37	82.37	0.068
2	12.7	10.0	153.0	153.0	73.0	6.60	3.11	3.11	0.785	82.18	82.18	0.068
3	13.6	10.0	153.0	153.0	73.0	7.60	2.01	2.01	1.767	82.07	82.07	0.068
4	14.6	10.0	153.0	153.0	73.0	8.50	1.25	1.25	3.142	81.98	81.98	0.068
5	15.2	10.0	153.0	153.0	73.0	9.20	0.50	0.50	6.284	81.90	81.90	0.068
6	15.5	10.0	153.0	153.0	73.0	9.50	0.25	0.25	9.621	81.87	81.87	0.067
7	15.5	10.0	152.0	152.0	73.0	9.50	0.14	0.14	13.548	81.81	81.81	0.067
8	15.6	10.0	152.0	152.0	73.0	9.60	0.10	0.10	15.512	81.80	81.80	0.067
9	15.6	10.0	152.0	152.0	73.0	9.60	0.08	0.08	17.082	81.80	81.80	0.067
10	15.7	10.0	150.0	150.0	73.0	9.70	0.0	0.0	*****	81.65	81.65	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8

PHS(IN. H2O): -1.25 -0.74 -0.37 -0.10

PHS*: -0.09 -0.06 -0.03 -0.01

(e) S/D = 0.75, $M_u = 0.068$

Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.75

1/0/2/075/05

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 6.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 2.00

1/2 TAKE DIAMETER: 3.00 INCHES

AREA RATIO, AN/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.80 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MAC4
1	5.7	5.0	149.0	149.0	73.0	2.70	2.16	2.16	0.0	0.0	174.96	58.32	58.32	0.048
2	6.2	5.0	149.0	149.0	73.0	3.20	1.54	1.54	0.785	0.033	174.85	67.22	58.28	0.040
3	6.9	5.0	149.0	149.0	73.0	3.80	1.05	1.05	1.767	0.061	174.74	74.89	58.24	0.048
4	7.3	5.0	149.0	149.0	73.0	4.20	0.62	0.62	3.142	0.084	174.66	80.90	58.22	0.048
5	7.7	5.0	149.0	149.0	73.0	4.60	0.24	0.24	6.284	0.103	174.57	86.26	58.19	0.048
6	7.8	5.0	149.0	149.0	73.0	4.80	0.11	0.11	9.621	0.108	174.51	87.58	58.17	0.048
7	7.9	5.0	149.0	149.0	73.0	4.80	0.06	0.06	13.548	0.113	174.53	88.77	58.17	0.048
8	7.9	5.0	149.0	149.0	73.0	4.80	0.05	0.05	15.512	0.118	174.53	90.16	58.17	0.048
9	8.0	5.0	150.0	150.0	73.0	4.80	0.04	0.04	17.082	0.123	174.69	91.64	58.23	0.048
10	7.8	5.0	152.0	152.0	73.0	4.70	0.0	0.0	*****	*****	174.98	*****	58.32	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8

PHS(IN. H2O): 0.0 0.0 0.0 0.0

PHS*: 0.0 0.0 0.0 0.0

(f) S/D = 0.75, $M_u \approx 0.048$
Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.50

1/0/2/050/15

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 6.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.79 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA	PA-P5 (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)
1	17.7	15.0	151.0	151.0	74.0	8.70	6.00	6.00	0.0
2	19.6	15.0	151.0	151.0	74.0	10.60	4.08	4.08	0.785
3	21.0	15.0	154.0	154.0	74.0	12.00	2.62	2.62	1.767
4	22.1	15.0	154.0	154.0	74.0	13.10	1.56	1.56	3.142
5	23.1	15.0	151.0	151.0	74.0	14.10	0.58	0.58	6.284
6	23.4	15.0	151.0	151.0	74.0	14.30	0.27	0.27	9.621
7	23.4	15.0	151.0	151.0	74.0	14.40	0.14	0.14	13.548
8	23.5	15.0	152.0	152.0	74.0	14.50	0.11	0.11	15.512
9	23.5	15.0	151.0	151.0	74.0	14.50	0.09	0.09	17.082
10	23.6	15.0	147.0	147.0	74.0	14.60	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*F**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MAC-H
1	0.0	0.3008	0.8739	0.3442	0.0	0.325	0.0	300.34	100.11	100.11	0.083
2	0.1651	0.2055	0.8739	0.2351	0.1555	0.325	0.054	299.64	114.49	99.87	0.082
3	0.2980	0.1318	0.8696	0.1515	0.2802	0.325	0.097	299.86	126.34	99.95	0.082
4	0.4083	0.0787	0.8696	0.0905	0.3840	0.326	0.133	299.46	136.08	99.81	0.082
5	0.4940	0.0292	0.8739	0.0334	0.4655	0.327	0.161	298.36	143.55	99.45	0.082
6	0.5181	0.0137	0.8739	0.0157	0.4882	0.327	0.169	298.32	145.72	99.44	0.082
7	0.5253	0.0071	0.8739	0.0081	0.4951	0.327	0.172	298.25	146.34	99.41	0.082
8	0.5213	0.0053	0.8725	0.0061	0.4909	0.327	0.170	298.46	146.01	99.48	0.082
9	0.5310	0.0046	0.8739	0.0052	0.5004	0.327	0.174	298.22	146.85	99.40	0.082
10	*****	0.0	0.8797	0.0	*****	0.328	*****	297.20	*****	99.06	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.0

PMS(IN. H2O): 0.0 0.0 0.0 0.0

PMS*: 0.0 0.0 0.0 0.0

(g) S/D = 0.50, $M_u = 0.082$
Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.50

1/0/2/050/10

NUMBER OF PRIMARY NOZZLES: 1

PRIMARY NOZZLE DIAMETER: 1.732 INCHES

MIXING STACK LENGTH: 6.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.79 INCHES HG

N RUN	POR (INCHES OF WATER)	OFOR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQARE INCHES)
1	11.6	10.0	148.0	148.0	74.0	5.70	4.08	4.08	0.0
2	12.9	10.0	148.0	148.0	74.0	6.90	2.72	2.72	0.785
3	13.9	10.0	152.0	152.0	74.0	7.90	1.79	1.79	1.767
4	14.7	10.0	152.0	152.0	74.0	8.60	1.06	1.06	3.142
5	15.3	10.0	152.0	152.0	74.0	9.20	0.39	0.39	6.284
6	15.5	10.0	152.0	152.0	74.0	9.40	0.20	0.20	9.621
7	15.6	10.0	152.0	152.0	74.0	9.50	0.11	0.11	13.548
8	15.6	10.0	152.0	152.0	74.0	9.60	0.09	0.09	15.512
9	15.6	10.0	148.0	148.0	74.0	9.60	0.07	0.07	17.082
10	15.7	10.0	145.0	145.0	74.0	9.70	0.0	0.0	*****

N RUN	W*	P*	T*	P*/f*	W* f** .44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3053	0.8782	0.3476	0.0	0.265	0.0	245.85	81.95	81.95	0.068
2	0.1652	0.2042	0.8782	0.2325	0.1560	0.266	0.044	245.46	93.74	81.81	0.068
3	0.3022	0.1338	0.8725	0.1534	0.2846	0.265	0.080	245.96	103.77	81.98	0.068
4	0.4132	0.0794	0.8725	0.0909	0.3891	0.265	0.110	245.78	111.77	81.92	0.068
5	0.5009	0.0292	0.8725	0.0335	0.4717	0.265	0.133	245.60	118.11	81.86	0.068
6	0.5421	0.0146	0.8725	0.0168	0.5106	0.265	0.144	245.54	121.09	81.84	0.068
7	0.5733	0.0083	0.8725	0.0095	0.5399	0.265	0.152	245.51	123.36	81.83	0.068
8	0.5770	0.0064	0.8725	0.0073	0.5434	0.265	0.153	245.45	123.61	81.81	0.067
9	0.5748	0.0053	0.8782	0.0060	0.5428	0.266	0.153	244.64	123.36	81.54	0.067
10	*****	0.0	0.8826	0.0	*****	0.267	*****	244.01	*****	81.33	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8

PMS(IN. H2O): -1.46 -1.00 -0.54 0.13

PMS*: -0.11 -0.08 -0.04 0.01

(h) S/D = 0.50, $M_u = 0.068$
Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HAKRELL

GNE NOZZLE, NO TRANSITION, STANDOFF 0.50

1/0/2/050/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.79 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	5.9	5.0	148.0	148.0	74.0	2.80	2.04	2.04	0.0
2	6.5	5.0	149.0	149.0	74.0	3.40	1.42	1.42	0.785
3	7.0	5.0	149.0	149.0	74.0	3.90	0.91	0.91	1.767
4	7.4	5.0	146.0	146.0	74.0	4.30	0.53	0.53	3.142
5	7.7	5.0	146.0	146.0	74.0	4.60	0.20	0.20	6.284
6	7.8	5.0	146.0	146.0	74.0	4.70	0.10	0.10	9.621
7	7.8	5.0	146.0	146.0	74.0	4.80	0.05	0.05	13.548
8	7.9	5.0	149.0	149.0	74.0	4.80	0.04	0.04	15.512
9	7.9	5.0	149.0	149.0	74.0	4.80	0.03	0.03	17.082
10	7.9	5.0	144.0	144.0	74.0	4.80	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W+T+P-44	WP (LBH/SEC)	WS (LBH/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3018	0.8782	0.3436	0.0	0.187	0.0	174.84	58.28	58.28	0.048
2	0.1692	0.2100	0.8768	0.2395	0.1597	0.187	0.032	174.86	66.88	58.28	0.048
3	0.3048	0.1348	0.8768	0.1537	0.2877	0.187	0.057	174.75	73.77	58.25	0.048
4	0.4124	0.0785	0.8811	0.0896	0.3900	0.188	0.077	174.23	79.18	58.07	0.048
5	0.5001	0.0291	0.8811	0.0330	0.4730	0.188	0.094	174.17	83.68	58.05	0.048
6	0.5343	0.0142	0.8811	0.0161	0.5054	0.188	0.100	174.15	85.44	58.05	0.048
7	0.5459	0.0075	0.8811	0.0085	0.5163	0.188	0.103	174.11	86.02	58.03	0.048
8	0.5604	0.0059	0.8768	0.0068	0.5289	0.188	0.105	174.56	86.82	58.18	0.048
9	0.5772	0.0052	0.8768	0.0059	0.5448	0.188	0.108	174.56	87.68	58.18	0.048
10	*****	0.0	0.8840	0.0	*****	0.189	*****	173.84	*****	57.54	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8

PMS(LN. H2O): 0.0 0.0 0.0 0.0 0.0

PMS*: 0.0 0.0 0.0 0.0 0.0

(i) S/D = 0.50, $M_u = 0.048$

Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.25

1/70/2/025/15

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 2.00

U* WAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AH/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.79 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (LBM/SEC)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UU (FT/SEC)	JPT MACH
1	18.2	15.0	155.0	155.0	75.0	9.20	5.58	5.58	0.0	100.37	100.37	0.083
2	20.0	15.0	156.0	156.0	75.0	11.00	3.74	3.74	0.785	114.22	100.23	0.082
3	21.3	15.0	156.0	156.0	75.0	12.30	2.25	2.25	1.767	124.55	100.07	0.082
4	22.4	15.0	156.0	156.0	75.0	13.30	1.27	1.27	3.142	132.70	99.96	0.082
5	23.0	15.0	156.0	156.0	75.0	14.00	0.45	0.45	6.284	138.87	99.87	0.082
6	23.2	15.0	157.0	157.0	75.0	14.10	0.21	0.21	9.621	140.24	99.95	0.082
7	23.3	15.0	154.0	154.0	75.0	14.30	0.11	0.11	13.548	140.31	99.67	0.082
8	23.3	15.0	154.0	154.0	75.0	14.30	0.08	0.08	15.512	140.29	99.59	0.082
9	23.3	15.0	153.0	153.0	75.0	14.30	0.07	0.07	17.082	139.92	99.53	0.082
10	22.9	15.0	152.0	152.0	75.0	14.00	0.0	0.0	*****	*****	*****	0.082

N RUN	W*	P*	T*	P*/T*	W*F**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	JPT MACH
1	0.0	0.2788	0.8638	0.3205	0.0	0.324	0.0	301.14	100.37	100.37	0.083
2	0.1584	0.1874	0.8684	0.2158	0.1489	0.324	0.051	300.72	114.22	100.23	0.082
3	0.2762	0.1131	0.8684	0.1302	0.2596	0.325	0.090	300.24	124.55	100.07	0.082
4	0.3685	0.0640	0.8684	0.0737	0.3463	0.325	0.120	299.91	132.70	99.96	0.082
5	0.4384	0.0277	0.8684	0.0262	0.4120	0.325	0.143	299.62	138.87	99.87	0.082
6	0.4533	0.0103	0.8570	0.0119	0.4257	0.325	0.147	299.86	140.24	99.95	0.082
7	0.4537	0.0053	0.8713	0.0061	0.4289	0.326	0.149	299.02	140.31	99.67	0.082
8	0.4554	0.0041	0.8713	0.0047	0.4286	0.326	0.148	299.02	140.29	99.59	0.082
9	0.4517	0.0033	0.8727	0.0038	0.4254	0.326	0.147	298.78	139.92	99.53	0.082
10	*****	0.0	0.8741	0.0	*****	0.326	*****	298.61	*****	*****	0.082

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8
 PMSIN. H2O: 0.0 0.0 0.0 0.0
 PMS*: 0.0 0.0 0.0 0.0

(j) S/D = 0.25, $M_u = 0.082$
 Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.25

1/0/2/025/10

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 2.00

N	POR	DPOR	TOR	TUPT	TAMB	PJ-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)	(INCHES OF WATER)	(SQUARE INCHES)	
1	12.1	10.0	154.0	154.0	75.0	6.00	3.78	3.78	0.0
2	13.2	10.0	154.0	154.0	75.0	7.10	7.53	2.53	0.785
3	14.2	10.0	153.0	153.0	75.0	8.10	1.55	1.55	1.767
4	14.7	10.0	153.0	153.0	75.0	8.60	0.88	0.88	3.142
5	15.3	10.0	153.0	153.0	75.0	9.20	0.34	0.34	6.284
6	15.4	10.0	153.0	153.0	75.0	9.40	0.16	0.16	9.621
7	15.5	10.0	153.0	153.0	75.0	9.40	0.09	0.09	13.548
8	15.5	10.0	153.0	153.0	75.0	9.40	0.06	0.06	15.512
9	15.5	10.0	153.0	153.0	75.0	9.40	0.05	0.05	17.082
10	15.5	10.0	145.0	145.0	75.0	9.50	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W+T**44	WP	WS	UP	UM	UU	UPT
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	MACH
1	0.0	0.2808	0.8713	0.3223	0.0	0.264	0.0	246.97	82.32	82.32	0.068
2	0.1599	0.1884	0.8713	0.2163	0.1505	0.264	0.042	246.63	93.70	82.21	0.068
3	0.2811	0.1159	0.8727	0.1328	0.2648	0.265	0.074	246.13	102.33	82.04	0.068
4	0.3754	0.0655	0.8727	0.0751	0.3535	0.265	0.099	245.98	109.13	81.99	0.068
5	0.4642	0.0251	0.8727	0.0288	0.4372	0.265	0.123	245.80	115.55	81.93	0.068
6	0.4911	0.0120	0.8727	0.0138	0.4625	0.265	0.130	245.71	117.48	81.90	0.068
7	0.5186	0.0068	0.8727	0.0077	0.4884	0.265	0.138	245.74	119.49	81.91	0.068
8	0.4848	0.0045	0.8727	0.0052	0.4566	0.265	0.129	245.74	117.04	81.91	0.068
9	0.4874	0.0038	0.8727	0.0043	0.4590	0.265	0.129	245.74	117.22	81.91	0.068
10	*****	0.0	0.8842	0.0	*****	0.267	*****	244.07	*****	81.35	0.067

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8
 PHS(IN. H2O): -1.37 -0.93 -0.55 -0.12
 PMS*: -0.10 -0.07 -0.04 -0.01

(k) S/D = 0.25, $M_u = 0.068$
 Table XIII. Continued.

DATA TAKEN 19 JULY 77 BY PETE HARRELL

ONE NOZZLE, NO TRANSITION, STANDOFF 0.25

1/0/2/025/05

NUMBER OF PRIMARY NOZZLES: 1
 PRIMARY NOZZLE DIAMETER: 1.732 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 2.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE UFTA: 0.70
 AMBIENT PRESSURE: 29.79 INCHES HG

N RUN	PR (INCHES OF WATER)	DPOR (INCHES OF WATER)	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PQ-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PHZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	6.1	5.0	150.0	150.0	75.0	3.00	1.94	1.94	0.0
2	6.6	5.0	150.0	150.0	75.0	3.50	1.30	1.30	0.785
3	7.1	5.0	150.0	150.0	75.0	4.00	0.79	0.79	1.767
4	7.5	5.0	150.0	150.0	75.0	4.40	0.45	0.45	3.142
5	7.7	5.0	150.0	150.0	75.0	4.60	0.16	0.16	6.284
6	7.8	5.0	150.0	150.0	75.0	4.70	0.07	0.07	9.621
7	7.8	5.0	150.0	150.0	75.0	4.70	0.03	0.03	13.548
8	7.9	5.0	150.0	150.0	75.0	4.70	0.03	0.03	15.512
9	7.9	5.0	151.0	151.0	75.0	4.80	0.03	0.03	17.082
10	7.8	5.0	149.0	149.0	75.0	4.70	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*1**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UI (FT/SEC)	UPT MACH
1	0.0	0.2867	0.8770	0.3269	0.0	0.187	0.0	175.09	58.36	58.36	0.048
2	0.1619	0.1924	0.8770	0.2193	0.1528	0.187	0.030	174.98	66.56	58.32	0.048
3	0.2830	0.1163	0.8770	0.1326	0.2671	0.187	0.053	174.87	72.71	58.29	0.048
4	0.3787	0.0660	0.8770	0.0752	0.3575	0.187	0.071	174.79	77.59	58.26	0.048
5	0.4469	0.0230	0.8770	0.0262	0.4218	0.187	0.084	174.74	81.08	58.24	0.048
6	0.4598	0.0104	0.8770	0.0118	0.4340	0.187	0.086	174.72	81.74	58.24	0.048
7	0.4578	0.0052	0.8770	0.0059	0.4321	0.187	0.086	174.72	81.64	58.24	0.048
8	0.4429	0.0037	0.8770	0.0042	0.4181	0.187	0.093	174.74	80.89	58.24	0.048
9	0.4882	0.0037	0.8755	0.0042	0.4604	0.187	0.091	174.84	83.21	58.28	0.048
10	*****	0.0	0.8784	0.0	*****	0.188	*****	174.58	*****	58.19	0.048

MIXING STACK PRESSURE DISTRIBUTION FOR RUN: 10

X/D: 0.3 0.8 1.3 1.8

PMS(IN. H2O): 0.0 0.0 0.0 0.0

PMS*: 0.0 0.0 0.0 0.0

(1) S/D = 0.25, $M_u = 0.048$

Table XIII. Continued.

DATA TAKEN 28 JULY 77 BY PÉTE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.50

4/1/7.57/050/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 2.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.91 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	12.7	10.0	151.0	151.0	72.0	6.70	4.83	4.83	0.0
2	13.8	10.0	151.0	151.0	73.0	7.80	3.74	3.74	0.785
3	15.0	10.0	151.0	151.0	73.0	9.00	2.59	2.59	1.767
4	15.9	10.0	151.0	151.0	73.0	5.90	1.64	1.64	3.142
5	17.0	10.0	151.0	151.0	73.0	11.00	0.67	0.67	6.284
6	17.3	10.0	151.0	151.0	73.0	11.30	0.33	0.33	5.621
7	17.4	10.0	152.0	152.0	73.0	11.40	0.18	0.18	13.548
8	17.6	10.0	151.0	151.0	73.0	11.50	0.12	0.12	17.081
9	17.6	10.0	150.0	150.0	73.0	11.60	0.0	0.0	*****

N RUN	W*	P*	T*	PA/TA	WAT*	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	LU (FT/SEC)	UPY MACH
1	0.0	0.3401	0.8723	0.3899	0.0	0.265	0.0	252.68	84.22	84.22	0.070
2	0.1942	0.2641	0.8723	0.3027	0.1828	0.266	0.052	252.32	98.21	84.10	0.069
3	0.3632	0.1834	0.8723	0.2103	0.3420	0.266	0.097	251.96	110.42	83.98	0.069
4	0.5529	0.1164	0.8723	0.1335	0.4834	0.266	0.137	251.64	121.28	82.88	0.069
5	0.7039	0.0473	0.8723	0.0542	0.6148	0.267	0.174	251.36	131.42	83.78	0.069
6	0.7326	0.0235	0.8723	0.0269	0.6628	0.267	0.180	251.25	135.12	82.74	0.069
7	0.7533	0.0128	0.8708	0.0147	0.6893	0.267	0.195	251.39	137.22	83.75	0.069
8	*****	0.0085	0.8722	0.0098	0.7094	0.267	0.201	251.20	138.73	83.73	0.069
9	*****	0.0	0.8737	0.0	*****	0.267	*****	250.92	*****	83.64	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS A (IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS* A:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS B (IN. H2O):	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PMS* B:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(a) S/D = 0.50

Table XIV. Four-Nozzle Performance Data for L/D = 7.57, $M_u = 0.068$, Elliptic Transition.

DATA TAKEN 28 JULY 77 BY PETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 3.25 4/17.57/025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 25.91 INCHES HG

N RUN	POR (INCHES OF WATER)	DPOR	TOR (DEGREES FAHRENHEIT)	TUFT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UU (FT/SEC)	UM (FT/SEC)	UPT MACH
1	12.6	10.0	152.0	152.0	73.0	6.50	5.00	5.00	0.0	84.32	84.32	0.070
2	13.8	10.0	151.0	151.0	73.0	7.70	3.84	3.84	0.785	84.12	84.12	0.069
3	14.9	10.0	151.0	151.0	73.0	8.90	2.68	2.68	1.767	82.99	82.99	0.069
4	15.9	10.0	152.0	152.0	73.0	9.80	1.71	1.71	3.142	83.56	83.56	0.069
5	16.9	10.0	151.0	151.0	73.0	10.80	0.69	0.69	6.284	83.78	83.78	0.069
6	17.3	10.0	152.0	152.0	73.0	11.20	0.34	0.34	9.621	83.81	83.81	0.069
7	17.4	10.0	151.0	151.0	73.0	11.40	0.18	0.18	13.548	83.72	83.72	0.069
8	17.5	10.0	152.0	152.0	73.0	11.40	0.12	0.12	17.061	93.79	93.79	0.069
9	17.6	10.0	147.0	147.0	73.0	11.60	0.0	0.0	*****	83.43	83.43	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR PMS: 9

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0
PMS A (IN. H2O):	-0.940	-0.500	-0.120	0.075	0.135	0.205	0.220	0.220	0.175	0.125	0.130	0.045
PMS* A:	-0.067	-0.036	-0.009	0.005	0.010	0.015	0.016	0.016	0.013	0.009	0.005	0.003
PMS B (IN. H2O):	-0.925	-0.550	-0.185	0.030	0.115	0.195	0.215	0.215	0.175	0.130	0.125	0.040
PMS* B:	-0.066	-0.039	-0.013	0.002	0.008	0.014	0.015	0.015	0.013	0.009	0.009	0.003

(b) S/D = 0.25

Table XIV. Continued.

DATA TAKEN 29 JULY 77 BY PETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 3.0

4/1/7-57/0/10

NUMBER OF PRIMARY NOZZLES: 4

PRIMARY NOZZLE DIAMETER: 0.866 INCHES

MIXING STACK LENGTH: 22.71 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.75 INCHES HG

N	POR	UPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)			(SQUARE INCHES)
2	13.6	10.0	149.0	148.0	75.0	7.60	3.93	3.93	0.785
1	12.5	10.0	148.0	148.0	75.0	6.40	5.16	5.16	0.0
3	14.9	10.0	148.0	148.0	75.0	8.80	2.72	2.72	1.767
4	15.8	10.0	148.0	148.0	75.0	9.80	1.77	1.77	3.142
5	16.9	10.0	148.0	148.0	75.0	10.80	0.74	0.74	6.284
6	17.1	10.0	148.0	148.0	75.0	11.10	0.38	0.38	9.621
7	17.2	10.0	148.0	148.0	75.0	11.20	0.22	0.22	13.548
8	17.3	10.0	148.0	148.0	75.0	11.30	0.15	0.15	17.061
9	17.5	10.0	145.0	145.0	75.0	11.40	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UM	UU	UPT
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	MACH
1	0.0	0.3660	0.8799	0.4159	0.0	0.265	0.0	252.92	84.30	84.30	0.070
2	0.1982	0.2797	0.8799	0.3179	0.1873	0.266	0.053	252.47	98.68	84.15	0.070
3	0.3706	0.1942	0.8799	0.2207	0.3503	0.266	0.099	252.10	111.24	84.03	0.070
4	0.5310	0.1267	0.8799	0.1440	0.5019	0.266	0.141	251.78	122.96	83.92	0.069
5	0.6857	0.0531	0.8799	0.0603	0.6482	0.267	0.183	251.47	134.30	83.82	0.069
6	0.7522	0.0273	0.8799	0.0310	0.7110	0.267	0.201	251.30	139.14	83.76	0.069
7	0.7966	0.0155	0.8799	0.0176	0.7530	0.267	0.212	251.23	142.40	83.74	0.069
8	0.8247	0.0104	0.8799	0.0113	0.7795	0.267	0.220	251.21	144.47	83.73	0.069
9	*****	0.0	0.8842	0.0	*****	0.267	*****	250.56	*****	83.52	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS A (IN. H2O):	-1.200	-0.725	-0.290	-0.040	0.075	0.170	0.205	0.205	0.165	0.11F	0.130	0.043	0.030
PMS* A:	-0.087	-0.052	-0.021	-0.003	0.005	0.012	0.015	0.015	0.012	0.008	0.005	0.003	0.002
PMS B (IN. H2O):	-1.180	-0.810	-0.405	-0.125	0.040	0.150	0.190	0.200	0.165	0.120	0.135	0.045	0.025
PMS* B:	-0.085	-0.059	-0.029	-0.009	0.003	0.011	0.014	0.014	0.012	0.009	0.010	0.003	0.002

(c) S/D = 0.0

Table XIV. Continued.

DATA TAKEN 28 JULY 77 BY PETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF -0.25 4/1/7.57/-025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 22.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 7.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.91 INCHES HG

N RUN	POR (INCHES OF WATER)	UPOR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	12.4	10.0	152.0	152.0	73.0	6.40	5.18	5.18	0.0
2	13.8	10.0	151.0	151.0	73.0	7.70	3.94	3.94	0.765
3	14.8	10.0	152.0	152.0	73.0	8.70	2.74	2.74	1.767
4	15.7	10.0	151.0	151.0	73.0	9.60	1.80	1.80	3.142
5	16.6	10.0	152.0	152.0	73.0	10.50	0.73	0.73	6.284
6	16.8	10.0	152.0	152.0	73.0	10.80	0.36	0.36	9.621
7	17.1	10.0	151.0	151.0	73.0	11.00	0.19	0.19	13.548
8	17.1	10.0	152.0	152.0	73.0	11.10	0.13	0.13	17.081
9	17.2	10.0	148.0	148.0	73.0	11.20	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	WAT**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3638	0.8708	0.4177	0.0	0.265	0.0	253.01	84.33	84.33	0.070
2	0.1993	0.2779	0.8723	0.2186	0.1876	0.266	0.053	252.45	98.63	84.14	0.069
3	0.3739	0.1937	0.8708	0.2224	0.3518	0.266	0.099	252.20	111.25	84.06	0.069
4	0.5379	0.1277	0.8723	0.1465	0.5065	0.266	0.143	251.68	123.07	83.89	0.069
5	0.6826	0.0515	0.8708	0.0592	0.6423	0.266	0.182	251.49	133.56	83.82	0.069
6	0.7362	0.0256	0.8708	0.0294	0.6928	0.266	0.196	251.32	137.43	83.77	0.069
7	0.7523	0.0135	0.8723	0.0155	0.7084	0.267	0.201	251.10	138.59	83.69	0.069
8	0.7699	0.0089	0.8708	0.0102	0.7245	0.266	0.205	251.26	139.89	83.75	0.069
9	*****	0.0	0.8766	0.0	*****	0.267	*****	250.39	*****	83.46	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D:	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
PMS A (IN. H2O):	-1.470	-0.985	-0.545	-0.215	-0.045	0.125	0.180	0.205	0.175	0.130	0.140	0.050	0.040
PMS* A:	-0.105	-0.071	-0.039	-0.015	-0.003	0.009	0.013	0.015	0.013	0.009	0.010	0.004	0.003
PMS B (IN. H2O):	-1.370	-0.970	-0.625	-0.305	-0.060	0.100	0.165	0.185	0.165	0.125	0.130	0.050	0.035
PMS* B:	-0.098	-0.070	-0.045	-0.022	-0.004	0.007	0.012	0.013	0.012	0.009	0.009	0.004	0.003

(d) S/D = -0.25

Table XIV. Continued.

DATA TAKEN 11 AUG 77 BY PETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.25 4/1/5-57/025/10

NUMBER OF PRIMARY NOZZLES: 4
 UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 URIFICE DIAMETER: 2.154 INCHES
 MIXING STACK LENGTH: 16.71 INCHES
 ORIFICE BETA: 0.70
 MIXING STACK DIAMETER: 3.00 INCHES
 AMBIENT PRESSURE: 29.72 INCHES HG
 MIXING STACK L/D: 5.57

N RUN	PCR (INCHES CF WATER)	TOR (DEGREES FAHRENHEIT)	YUPT	YAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	12.5	10.0	146.0	72.0	6.40	5.08	5.08	0.0
2	12.7	10.0	146.0	72.0	7.70	3.84	3.84	0.785
3	14.9	10.0	146.0	72.0	8.90	2.76	2.76	1.767
4	16.0	10.0	146.0	72.0	9.90	1.78	1.78	3.142
5	17.0	10.0	146.0	72.0	10.90	0.73	0.73	6.284
6	17.2	10.0	146.0	72.0	11.20	0.36	0.36	9.621
7	17.5	10.0	146.0	72.0	11.40	0.20	0.20	13.548
8	17.5	10.0	146.0	72.0	11.50	0.13	0.13	17.081
9	17.6	10.0	146.0	72.0	11.60	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*/T*	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3596	0.8778	0.4096	0.0	0.266	0.0	252.58	84.19	84.19	0.070
2	0.1561	0.2727	0.8778	0.3107	0.1852	0.266	0.052	252.16	98.38	84.05	0.070
3	0.3737	0.1565	0.8778	0.2239	0.3529	0.266	0.100	251.85	111.29	83.94	0.070
4	0.5329	0.1270	0.8778	0.1447	0.5033	0.267	0.142	251.56	122.90	83.85	0.070
5	0.6755	0.0519	0.8778	0.0591	0.6416	0.267	0.181	251.20	133.58	83.73	0.069
6	0.7329	0.0258	0.8778	0.0294	0.6920	0.267	0.196	251.04	137.45	83.67	0.069
7	0.7593	0.0140	0.8778	0.0159	0.7169	0.267	0.203	251.02	139.41	83.67	0.069
8	0.7816	0.0093	0.8778	0.0106	0.7380	0.267	0.209	250.98	141.03	83.66	0.069
9	*****	0.0	0.8778	0.0	*****	0.267	*****	250.93	*****	83.64	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
 PMS A (IN. H2O): -1.050 -0.640 -0.310 -0.055 0.0 0.020 0.025 0.075 0.055
 PMS A: -0.075 -0.046 -0.022 -0.004 0.0 0.001 0.002 0.005 0.004
 PMS B (IN. H2O): -1.020 -0.665 -0.345 -0.105 -0.015 0.010 0.015 0.070 0.040
 PMS B: -0.073 -0.048 -0.025 -0.008 -0.001 0.001 0.001 0.005 0.003

(a) S/D = 0.25

Table XV. Four-Nozzle Performance Data for L/D = 5.57, $M_u = 0.068$, Elliptic Transition.

DATA TAKEN 11 AUG 77 BY PETE FARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0

4/1/5.57/0/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 16.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 5.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.72 INCHES HG

N	FCR	EPGR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA	UPT MACH
RUN	(INCHES OF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)						(SQUARE INCHES)	(FT/SEC)
1	12.5	10.0	146.0	146.0	72.0	6.40	5.20	5.20	0.0	0.070
2	13.7	10.0	146.0	146.0	72.0	7.60	3.94	3.94	0.785	0.070
3	14.5	10.0	146.0	146.0	72.0	8.80	2.80	2.80	1.767	0.070
4	15.8	10.0	146.0	146.0	72.0	9.70	1.81	1.81	3.142	0.069
5	16.9	10.0	146.0	146.0	72.0	10.80	0.76	0.76	6.284	0.069
6	17.2	10.0	146.0	146.0	72.0	11.10	0.38	0.38	9.621	0.069
7	17.4	10.0	146.0	146.0	72.0	11.30	0.21	0.21	13.548	0.069
8	17.4	10.0	146.0	146.0	72.0	11.30	0.14	0.14	17.081	0.069
9	17.5	10.0	146.0	146.0	72.0	11.50	0.0	0.0	*****	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

PMS 1 (IN. P20): -1.310 -0.885 -0.500 -0.180 -0.075 0.010 0.010 0.075 0.055

PMS A: -0.094 -0.063 -0.036 -0.013 -0.005 0.001 0.001 0.005 0.004

PMS B (IN. P20): -1.240 -0.865 -0.525 -0.240 -0.050 -0.020 0.0 0.065 0.040

PMS B: -0.089 -0.062 -0.038 -0.017 -0.006 -0.001 0.0 0.005 0.003

(b) S/D = 0.0

Table XV. Continued.

DATA TAKEN 11 AUG 17 BY PETE HAKRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF -0.25 4/15-57/-025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 16.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 5.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.72 INCHES HG

N RUN	PCR (INCHES CF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES CF WATER)	PA-PS (INCHES CF WATER)	PA-PNZ (INCHES CF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	12.5	146.0	146.0	72.0	6.30	5.22	5.22	0.0	84.22	84.22	0.070
2	13.6	146.0	146.0	72.0	7.60	3.97	3.57	0.785	98.64	84.07	0.070
3	14.8	146.0	146.0	72.0	8.70	2.81	2.81	1.767	111.54	83.94	0.070
4	15.7	146.0	146.0	72.0	9.60	1.84	1.84	3.142	123.54	83.83	0.069
5	16.6	146.0	146.0	72.0	10.50	0.76	0.76	6.263	134.74	83.70	0.069
6	16.9	146.0	146.0	72.0	10.80	0.40	0.40	9.621	139.99	83.65	0.069
7	17.0	146.0	146.0	72.0	11.00	0.21	0.21	13.548	141.46	83.62	0.069
8	17.2	146.0	146.0	72.0	11.10	0.14	0.14	17.081	143.17	83.63	0.069
9	17.3	146.0	146.0	72.0	11.20	0.0	0.0	*****	*****	83.61	0.069

N RUN	W*	P*	T*	P*/T*	W*100.44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.2652	0.8778	0.4206	0.0	0.266	0.0	252.67	84.22	84.22	0.070
2	0.1554	0.2618	0.8778	0.3210	0.1883	0.266	0.053	252.22	98.64	84.07	0.070
3	0.3771	0.2001	0.8778	0.2279	0.3561	0.266	0.100	251.85	111.54	83.94	0.070
4	0.5421	0.1314	0.8778	0.1496	0.5118	0.267	0.144	251.51	123.54	83.83	0.069
5	0.6960	0.0544	0.8778	0.0620	0.6572	0.267	0.186	251.11	134.74	83.70	0.069
6	0.7679	0.0283	0.8778	0.0323	0.7251	0.267	0.205	250.97	139.99	83.65	0.069
7	0.7884	0.0151	0.8778	0.0172	0.7445	0.267	0.210	250.88	141.46	83.62	0.069
8	0.8114	0.0100	0.8778	0.0114	0.7652	0.267	0.217	250.90	143.17	83.63	0.069
9	*****	0.0	0.8778	0.0	*****	0.267	*****	250.84	*****	83.61	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
 PMS A(LIN. H2O): -1.560 -1.100 -0.705 -0.340 -0.150 -0.050 -0.005 0.005 0.035
 PMS* A: -0.112 -0.079 -0.051 -0.024 -0.011 -0.004 -0.000 0.000 0.003
 PMS B(LIN. H2O): -1.450 -1.060 -0.725 -0.405 -0.170 -0.070 -0.020 0.055 0.035
 PMS* B: -0.104 -0.076 -0.052 -0.029 -0.012 -0.005 -0.001 0.004 0.003

(c) S/D = -0.25

Table XV. Continued.

DATA TAKEN 12 AUG 77 BY PETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.25 4/1/4.57/025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.76 INCHES HG

N RUN	PCR (INCHES OF WATER)	DPCR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	A-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	12.6	10.0	145.0	145.0	72.0	6.50	5.15	5.15	0.0
2	12.7	10.0	145.0	145.0	72.0	7.70	4.00	4.00	0.785
3	14.9	10.0	145.0	145.0	72.0	8.80	2.76	2.76	1.767
4	15.9	10.0	145.0	145.0	72.0	9.80	1.79	1.79	3.142
5	16.9	10.0	145.0	145.0	72.0	10.90	0.74	0.74	6.284
6	17.3	10.0	145.0	145.0	72.0	11.30	0.37	0.37	9.621
7	17.4	10.0	145.0	145.0	72.0	11.40	0.20	0.20	13.548
8	17.5	10.0	146.0	146.0	72.0	11.50	0.13	0.13	17.081
9	17.6	10.0	146.0	146.0	72.0	11.60	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3649	0.8793	0.4150	0.0	0.266	0.0	252.27	84.09	84.09	0.070
2	0.2000	0.2843	0.8793	0.3234	0.1890	0.266	0.053	251.88	98.57	83.55	0.070
3	0.3734	0.1968	0.8793	0.2239	0.3529	0.267	0.100	251.46	111.15	83.82	0.070
4	0.5341	0.1280	0.8793	0.1455	0.5047	0.267	0.143	251.15	122.85	83.71	0.069
5	0.6837	0.0527	0.8793	0.0599	0.6460	0.267	0.183	250.80	133.75	83.59	0.069
6	0.7423	0.0266	0.8793	0.0302	0.7014	0.267	0.199	250.69	138.04	83.56	0.069
7	0.7587	0.0140	0.8793	0.0159	0.7170	0.267	0.203	250.61	139.23	83.53	0.069
8	0.7664	0.0090	0.8778	0.0102	0.7237	0.267	0.205	250.80	139.82	83.60	0.069
9	*****	0.0	0.8778	0.0	*****	0.267	*****	250.76	*****	83.58	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0
 PMS # (IN. 120): -1.040 -0.565 -0.225 -0.140 -0.120 0.0 0.060
 PMS* A: -0.075 -0.042 -0.016 -0.010 -0.009 0.0 0.004
 PMS B (IN. 120): -1.050 -0.680 -0.250 -0.165 -0.090 -0.010 0.020
 PMS* B: -0.075 -0.049 -0.018 -0.012 -0.006 -0.001 0.001

(a) S/D = 0.25

Table XVI. Four-Nozzle Performance Data for L/D = 4.57, $M_u = 0.068$, Elliptic Transition.

DATA TAKEN 12 AUG 77 BY PETE HAKRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0 4/1/4.57/0/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

N RUN	PCR (INCHES CF WATER)	DPCR	TUR	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS	PA-PNZ	SECONDARY AREA (SQUARE INCHES)
1	12.4	10.0	145.0	145.0	72.0	6.40	5.20	5.20	0.0
2	13.7	10.0	145.0	145.0	72.0	7.60	4.10	4.10	0.785
3	14.8	10.0	145.0	145.0	72.0	8.80	2.81	2.81	1.767
4	15.8	10.0	145.0	145.0	72.0	9.70	1.83	1.83	3.142
5	16.9	10.0	145.0	145.0	72.0	10.80	0.77	0.77	6.284
6	17.2	10.0	145.0	145.0	72.0	11.20	0.38	0.38	9.621
7	17.3	10.0	145.0	145.0	72.0	11.30	0.21	0.21	13.548
8	17.4	10.0	145.0	145.0	72.0	11.40	0.13	0.13	17.081
9	17.5	10.0	146.0	146.0	72.0	11.50	0.0	0.0	*****

N RUN	%	P*	T*	P*/T*	W*/T**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3686	0.8793	0.4192	0.0	0.266	0.0	252.24	84.08	84.08	0.070
2	0.2025	0.2913	0.8793	0.3313	0.1913	0.266	0.054	251.94	98.77	83.98	0.070
3	0.3768	0.2004	0.8793	0.2279	0.3561	0.267	0.100	251.46	111.39	83.82	0.070
4	0.5401	0.1208	0.8793	0.1488	0.5104	0.267	0.144	251.15	123.28	83.71	0.069
5	0.6975	0.0548	0.8793	0.0624	0.6591	0.267	0.186	250.82	134.77	83.60	0.069
6	0.7523	0.0273	0.8793	0.0310	0.7109	0.267	0.201	250.67	138.77	83.55	0.069
7	0.7780	0.0147	0.8793	0.0167	0.7352	0.267	0.208	250.59	140.63	83.52	0.069
8	0.7811	0.0093	0.8793	0.0106	0.7381	0.267	0.209	250.57	140.86	83.52	0.069
9	*****	0.0	0.8778	0.0	*****	0.267	*****	250.73	*****	83.57	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0
 PMS A (IN. P20): -1.330 -0.845 -0.350 -0.260 -0.160 -0.020 0.055
 PMS A: -0.095 -0.061 -0.025 -0.019 -0.011 -0.001 0.004
 PMS B (IN. P20): -1.260 -0.880 -0.380 -0.280 -0.170 -0.035 0.025
 PMS B: -0.090 -0.063 -0.027 -0.020 -0.012 -0.003 0.002

(b) S/D = 0.0

Table XVI. Continued.

DATA TAKEN 12 AUG 77 BY FELE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF -0.25 4/1/4.57/-025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 13.71 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.57

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.76 INCHES HG

N RUN	PCR (INCHES CF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	12.4	145.0	149.0	72.0	6.30	5.25	5.25	0.0
2	13.6	149.0	149.0	72.0	7.60	4.08	4.08	0.785
3	14.7	145.0	149.0	72.0	8.60	2.81	2.81	1.767
4	15.7	149.0	149.0	72.0	9.60	1.86	1.86	3.142
5	16.7	149.0	149.0	72.0	10.60	0.78	0.78	6.284
6	17.0	149.0	149.0	72.0	10.90	0.39	0.39	9.621
7	17.1	149.0	149.0	72.0	11.10	0.21	0.21	13.548
8	17.1	149.0	149.0	72.0	11.10	0.14	0.14	17.081
9	17.2	146.0	146.0	72.0	11.20	0.0	0.0	*****

N RUN	M*	P*	T*	P*/T*	W/T**44	MP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3656	0.8735	0.4231	0.0	0.265	0.0	253.11	84.36	84.36	0.070
2	0.2027	0.2861	0.8735	0.3298	0.1910	0.265	0.054	252.73	99.00	84.24	0.070
3	0.3781	0.1591	0.8735	0.2280	0.3563	0.266	0.100	252.26	111.66	84.08	0.070
4	0.5463	0.1321	0.8735	0.1513	0.5148	0.266	0.145	251.97	123.88	83.58	0.069
5	0.7045	0.0552	0.8735	0.0632	0.6638	0.266	0.188	251.59	135.36	83.86	0.069
6	0.7600	0.0275	0.8735	0.0314	0.7160	0.266	0.202	251.44	139.39	83.81	0.069
7	0.7808	0.0146	0.8735	0.0168	0.7357	0.266	0.208	251.35	140.89	83.78	0.069
8	0.7989	0.0096	0.8735	0.0110	0.7527	0.266	0.213	251.31	142.20	83.77	0.069
9	*****	0.0	0.8778	0.0	*****	0.267	*****	250.64	*****	83.54	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.5 1.0 1.5 2.0 2.5 3.0

PMS A (IN. H2O): -1.530 -1.440 -0.480 -0.395 -0.260 -0.065 0.025

PMS* A: -0.110 -0.034 -0.028 -0.019 -0.005 0.002

PMS B (IN. H2O): -1.450 -1.070 -0.500 -0.410 -0.235 -0.080 0.0

PMS* B: -0.104 -0.036 -0.029 -0.017 -0.006 0.0

(c) S/D = -0.25

Table XVI. Continued.

DATA TAKEN 19 AUG 77 BY PETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.25 4/1/3/025/10

NUMBER OF PRIMARY ACZZLES: 4
 PRIMARY ACZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.83 INCHES HG

N RUN	PCR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)
1	12.5	10.0	154.0	75.0	6.40	5.10	5.10	0.0
2	13.7	10.0	154.0	75.0	7.60	4.00	4.00	0.785
3	14.9	10.0	154.0	75.0	8.80	2.80	2.80	1.767
4	15.9	10.0	154.0	75.0	9.90	1.79	1.79	3.142
5	17.0	10.0	154.0	75.0	10.90	0.74	0.74	6.284
6	17.3	10.0	154.0	75.0	11.20	0.37	0.37	9.621
7	17.4	10.0	154.0	75.0	11.40	0.20	0.20	13.548
8	17.6	10.0	154.0	75.0	11.50	0.13	0.13	17.081
9	17.7	10.0	153.0	75.0	11.60	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*/T*	WP (LBH/SEC)	WS (LBH/SEC)	UP (FT/SEC)	UH (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3583	0.8713	0.4113	0.0	0.264	0.0	253.76	84.58	84.58	0.070
2	0.2009	0.2818	0.8713	0.3234	0.1891	0.265	0.053	253.43	99.11	84.47	0.070
3	0.2778	0.1579	0.8713	0.2271	0.3556	0.265	0.100	253.04	111.91	84.34	0.069
4	0.5366	0.1268	0.8713	0.1456	0.5050	0.265	0.142	252.71	123.43	84.23	0.069
5	0.6891	0.0526	0.8713	0.0603	0.6485	0.266	0.183	252.38	134.53	84.12	0.069
6	0.7407	0.0260	0.8713	0.0298	0.6971	0.266	0.197	252.24	138.28	84.07	0.069
7	0.7623	0.0139	0.8713	0.0159	0.7174	0.266	0.203	252.16	139.84	84.05	0.069
8	0.7645	0.0092	0.8713	0.0106	0.7383	0.266	0.209	252.18	141.49	84.05	0.069
9	*****	0.0	0.8727	0.0	*****	0.266	*****	251.92	*****	83.97	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: -0.67 0.0 0.33 0.83 1.33 1.83
 PMS A (IN. H2O): -0.430 -1.070 -0.500 -0.345 -0.145 -0.015
 PMS* A: -0.031 -0.076 -0.036 -0.025 -0.010 -0.001
 PMS B (IN. H2O): -0.450 -1.010 -0.525 -0.420 -0.170 -0.040
 PMS* B: -0.032 -0.072 -0.037 -0.030 -0.012 -0.003

(a) S/D = 0.25

Table XVII. Four-Nozzle Performance Data for L/D = 3,
 $M_u = 0.068$, Elliptic Transition.

DATA TAKEN 19 AUG 77 BY PETE HARRELL

FLUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0 4/1/3/0/10

NUMBER OF PRIMARY NOZZLES: 4
 UPTAKE DIAMETER: 3.00 INCHES
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 AREA RATIO, AM/AP: 3.00
 MIXING STACK LENGTH: 9.00 INCHES
 ORIFICE DIAMETER: 2.154 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 ORIFICE BETA: 0.70
 MIXING STACK L/C: 3.00
 AMBIENT PRESSURE: 29.83 INCHES HG

N	PLR	DP(R	TOR	TUT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES CF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(SQUARE INCHES)					
1	12.3	10.0	154.0	154.0	75.0	6.20	5.15	5.15	0.0
2	13.5	10.0	154.0	154.0	75.0	7.40	4.00	4.00	0.785
3	14.7	10.0	154.0	154.0	75.0	8.60	2.75	2.75	1.767
4	15.7	10.0	154.0	154.0	75.0	9.60	1.78	1.78	3.142
5	16.7	10.0	154.0	154.0	75.0	10.60	0.73	0.73	6.284
6	17.0	10.0	154.0	154.0	75.0	11.00	0.36	0.36	9.621
7	17.1	10.0	154.0	154.0	75.0	11.10	0.19	0.19	13.548
8	17.2	10.0	154.0	154.0	75.0	11.10	0.12	0.12	17.081
9	17.5	10.0	153.0	153.0	75.0	11.50	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UM	UU	UPT MACH
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	
1	0.0	0.2619	0.8713	0.4154	0.0	0.264	0.0	253.74	84.57	84.57	0.070
2	0.2010	0.2819	0.8713	0.3236	0.1891	0.265	0.053	253.37	99.09	84.45	0.070
3	0.3745	0.1545	0.8713	0.2232	0.3525	0.265	0.099	252.95	111.64	84.31	0.069
4	0.5352	0.1262	0.8713	0.1448	0.5037	0.265	0.142	252.64	123.30	84.21	0.069
5	0.6823	0.0515	0.8713	0.0592	0.6422	0.266	0.181	252.26	133.99	84.09	0.069
6	0.7358	0.0256	0.8713	0.0294	0.6925	0.266	0.195	252.14	137.88	84.04	0.069
7	0.7527	0.0135	0.8713	0.0155	0.7084	0.266	0.200	252.07	139.09	84.02	0.069
8	0.7541	0.0085	0.8713	0.0058	0.7097	0.266	0.200	252.05	139.19	84.01	0.069
9	*****	0.0	0.8727	0.0	*****	0.266	*****	251.86	*****	83.55	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: -0.67 0.0 0.33 0.83 1.33 1.83
 PMS A (IN. P2C1): -C.550 -1.260 -0.625 -0.500 -0.240 -0.040
 PMS* A: -0.039 -C.090 -0.045 -0.036 -0.017 -0.003
 PMS B (IN. P2C1): -0.580 -1.200 -0.640 -0.575 -0.250 -0.050
 PMS* B: -0.041 -0.086 -0.046 -0.041 -0.018 -0.004

(b) S/D = 0.0
 Table XVII. Continued.

CATA TAKEN 19 AUG 77 BY PETE HAKRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF -0.25 4/1/3/-025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

N	FCR	DPCR	TOR	TUPI	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES CF WATER)	(INCHES CF WATER)	(DEGREES FAHRENHEIT)			(INCHES CF WATER)	(INCHES CF WATER)	(SQARE INCHES)	
1	12.4	10.0	154.0	154.0	75.0	6.30	5.30	5.30	0.0
2	13.6	10.0	154.0	154.0	75.0	7.60	4.04	4.04	0.785
3	15.0	10.0	154.0	154.0	75.0	8.80	2.80	2.80	1.767
4	15.8	10.0	154.0	154.0	75.0	9.60	1.79	1.79	3.142
5	16.8	10.0	154.0	154.0	75.0	10.60	0.73	0.73	6.284
6	17.0	10.0	154.0	154.0	75.0	10.90	0.36	0.36	9.621
7	17.2	10.0	154.0	154.0	75.0	11.00	0.19	0.19	13.548
8	17.3	10.0	154.0	154.0	75.0	11.20	0.12	0.12	17.081
9	17.4	10.0	154.0	154.0	75.0	11.30	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W*T**44	WP	WS	UP	UN	UU	UPT	MACH
RUN						(LBM/SEC)	(LBM/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)		
1	0.0	0.3721	0.8713	0.4271	0.0	0.264	0.0	253.86	84.62	84.62	0.070	0.070
2	0.2019	0.2646	0.8713	0.3267	0.1901	0.265	0.053	253.43	99.19	84.47	0.070	0.070
3	0.3778	0.1978	0.8713	0.2270	0.3556	0.265	0.100	253.07	111.93	84.35	0.069	0.069
4	0.5366	0.1269	0.8713	0.1456	0.5050	0.265	0.142	252.68	123.42	84.22	0.069	0.069
5	0.6822	0.0515	0.8713	0.0591	0.6421	0.266	0.181	252.31	134.00	84.10	0.069	0.069
6	0.7358	0.0256	0.8713	0.0294	0.6925	0.266	0.195	252.14	137.88	84.04	0.069	0.069
7	0.7526	0.0135	0.8713	0.0155	0.7083	0.266	0.200	252.10	139.10	84.03	0.069	0.069
8	0.7540	0.0085	0.8713	0.0098	0.7096	0.266	0.200	252.08	139.20	84.02	0.069	0.069
9	*****	0.0	0.8713	0.0	*****	0.266	*****	252.04	*****	84.01	0.069	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: -0.67 0.0 0.33 0.83 1.33 1.83
 PMS A (IN. H2O): -0.655 -1.410 -0.755 -0.640 -0.530 -0.050
 PMS* A: -0.047 -0.100 -0.054 -0.046 -0.024 -0.004
 PMS B (IN. H2O): -0.690 -1.330 -0.720 -0.690 -0.380 -0.070
 PMS* B: -0.049 -0.095 -0.051 -0.049 -0.027 -0.005

(c) S/D = -0.25
 Table XVII. Continued.

CATA TAKEN 15 AUG 77 BY PETE PARRELL

FOUR NOZZLES, CONICAL TRANSITION, STANDOFF 0.25 4/2/4/025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 12.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.00

N	PCR	OPCR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA
RUN	(INCHES CF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(SQARE INCHES)					
1	12.8	10.0	154.0	154.0	76.0	6.70	4.84	4.84	0.0
2	13.8	10.0	154.0	154.0	76.0	7.70	3.92	3.52	0.785
3	14.8	10.0	154.0	154.0	76.0	8.80	2.78	2.78	1.767
4	15.8	10.0	154.0	154.0	76.0	9.80	1.82	1.82	3.142
5	16.9	10.0	154.0	154.0	76.0	10.80	0.75	0.75	6.284
6	17.3	10.0	154.0	154.0	76.0	11.10	0.37	0.37	9.621
7	17.3	10.0	154.0	154.0	76.0	11.30	0.20	0.20	13.548
8	17.4	10.0	154.0	154.0	76.0	11.30	0.13	0.13	17.081
9	17.5	10.0	151.0	151.0	76.0	11.50	0.0	0.0	*****

N	W*	P*	T*	P*/T*	W*/T*	WP	WS	UP	UM	UU	UPT
RUN						(LBH/SEC)	(LBH/SEC)	(FT/SEC)	(FT/SEC)	(FT/SEC)	MACH
1	0.0	0.3408	0.8729	0.3904	0.0	0.263	0.0	254.59	84.86	84.86	0.070
2	0.1587	0.2766	0.8729	0.3169	0.1871	0.264	0.052	254.31	99.32	84.77	0.070
3	0.3761	0.1568	0.8729	0.2255	0.3543	0.264	0.099	253.89	112.22	84.63	0.070
4	0.5405	0.1292	0.8729	0.1480	0.5091	0.264	0.143	253.59	124.22	84.52	0.070
5	0.6907	0.0530	0.8729	0.0607	0.6506	0.265	0.183	253.24	135.21	84.41	0.070
6	0.7449	0.0264	0.8729	0.0302	0.7017	0.265	0.157	253.12	139.18	84.37	0.069
7	0.7615	0.0139	0.8729	0.0159	0.7173	0.265	0.202	253.01	140.37	84.33	0.069
8	0.7686	0.0089	0.8729	0.0102	0.7240	0.265	0.204	253.00	140.89	84.33	0.069
9	*****	0.0	0.8772	0.0	*****	0.266	*****	252.33	*****	84.11	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D:	0.0	0.5	1.0	1.5	2.0	2.5
PMS A (IN. H2O):	-1.250	-C.485	-0.400	-0.205	-0.045	0.030
PMS* A:	-0.090	-0.035	-0.029	-0.015	-0.003	0.002
PMS B (IN. H2O):	-1.130	-C.475	-0.450	-0.225	-0.080	0.0
PMS* B:	-0.081	-C.034	-0.032	-0.016	-0.006	0.0

(a) S/D = 0.25

Table XVIII. Four-Nozzle Performance Data for L/D = 2,
 $M_u = 0.068$, Conical Transition.

DATA TAKEN 15 AUG 77 BY PETE HARRELL

FOUR NOZZLES, CONICAL TRANSITION, STANDOFF 0.0 4/24/0/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 12.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 4.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.63 INCHES HG

N RUN	POR (INCHES CF WATER)	DPCR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	12.6	10.0	154.0	154.0	76.0	6.50	5.08	5.08	0.0	0.263	0.0	254.69	84.89	0.070
2	13.7	10.0	154.0	154.0	76.0	7.60	4.00	4.00	0.785	0.264	0.053	254.33	84.77	0.070
3	14.8	10.0	154.0	154.0	76.0	8.70	2.82	2.82	1.767	0.264	0.100	253.92	84.63	0.070
4	15.7	10.0	154.0	154.0	76.0	9.60	1.83	1.83	3.142	0.264	0.143	253.56	84.52	0.070
5	16.8	10.0	154.0	154.0	76.0	10.70	0.75	0.75	6.284	0.265	0.184	253.21	84.40	0.070
6	17.2	10.0	154.0	154.0	76.0	11.00	0.37	0.37	9.621	0.265	0.197	253.09	84.36	0.069
7	17.2	10.0	154.0	154.0	76.0	11.10	0.20	0.20	13.548	0.265	0.204	252.99	84.32	0.069
8	17.2	10.0	154.0	154.0	76.0	11.10	0.13	0.13	17.081	0.265	0.204	252.94	84.31	0.069
9	17.5	10.0	153.0	153.0	76.0	11.40	0.0	0.0	*****	0.265	*****	252.75	84.24	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.5 1.0 1.5 2.0 2.5
 PMS A (IN. H2O): -1.480 -0.655 -0.600 -0.355 -0.100 -0.010
 PMS* A: -0.106 -0.047 -0.043 -0.025 -0.007 -0.001
 PMS B (IN. H2O): -1.340 -0.605 -0.655 -0.360 -0.150 -0.050
 PMS* B: -0.096 -0.043 -0.047 -0.026 -0.011 -0.004

(b) S/D = 0.0
 Table XVIII. Continued.

DATA TAKEN 15 AUG 77 BY PETE HARRELL

FOUR NOZZLES, CONICAL TRANSITION, STANDOFF -0.25 4/2/4/-025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 12.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/C: 4.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.63 INCHES HG

N	PCR	DPCR	TOR	YUPT	TAMB	PU-PA	PA-PS	PA-PN2	SECONDARY AREA	UPT MACH
RUN	(INCHES OF WATER)	(INCHES OF WATER)	(DEGREES FAHRENHEIT)			(INCHES OF WATER)	(INCHES OF WATER)	(SQARE INCHES)		
1	12.4	10.0	154.0	154.0	76.0	6.30	5.15	5.15	0.0	0.070
2	13.6	10.0	154.0	154.0	76.0	7.50	4.08	4.08	0.785	0.070
3	14.8	10.0	154.0	154.0	76.0	8.60	2.82	2.82	1.767	0.070
4	15.6	10.0	154.0	154.0	76.0	9.50	1.81	1.81	3.142	0.070
5	16.5	10.0	154.0	154.0	76.0	10.40	0.74	0.74	6.284	0.069
6	16.8	10.0	154.0	154.0	76.0	10.70	0.37	0.37	9.621	0.069
7	17.0	10.0	154.0	154.0	76.0	10.90	0.20	0.20	13.548	0.069
8	17.1	10.0	154.0	154.0	76.0	11.00	0.13	0.13	17.081	0.069
9	17.2	10.0	154.0	154.0	76.0	11.10	0.0	0.0	*****	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.5 1.0 1.5 2.0 2.5
 PMS A (IN. H2O): -1.620 -0.780 -0.760 -0.490 -0.160 -0.015
 PMS B (IN. H2O): -1.520 -0.710 -0.820 -0.535 -0.240 -0.080
 PMS C (IN. H2O): -0.108 -0.651 -0.059 -0.038 -0.017 -0.006

(c) S/D = -0.25
 Table XVIII. Continued.

DATA TAKEN 14 AUG 77 BY PETE FARRELL

FOUR NOZZLES, CONICAL TRANSITION, STANDOFF 0.25

4/2/3.0/025/10

NUMBER OF PRIMARY NOZZLES: 4

PRIMARY NOZZLE DIAMETER: 0.866 INCHES

MIXING STACK LENGTH: 9.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.72 INCHES HG

N RUN	PCR (INCHES OF WATER)	PCR	TOC	TOC (DEGREES FAHRENHEIT)	TOC	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	12.9	10.0	155.0	155.0	75.0	6.80	4.80	4.80	0.0	84.79	84.79	0.070
2	13.9	10.0	155.0	155.0	75.0	7.80	3.96	3.56	0.785	99.31	84.72	0.070
3	14.9	10.0	155.0	155.0	75.0	8.80	2.76	2.76	1.767	111.99	84.57	0.070
4	15.8	10.0	155.0	155.0	75.0	9.80	1.79	1.79	3.142	123.73	84.45	0.069
5	17.0	10.0	155.0	155.0	75.0	10.50	0.74	0.74	6.284	134.86	84.35	0.069
6	17.3	10.0	155.0	155.0	75.0	11.10	0.37	0.37	9.621	138.61	84.30	0.069
7	17.4	10.0	155.0	155.0	75.0	11.30	0.20	0.20	13.548	140.17	84.28	0.069
8	17.4	10.0	155.0	155.0	75.0	11.40	0.13	0.13	17.081	140.69	84.26	0.069
9	17.5	10.0	147.0	147.0	75.0	11.50	0.0	0.0	*****	251.11	83.70	0.069

N RUN	M*	P*	T*	P*/T*	M*/T*	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.2268	0.8698	0.3872	0.0	0.264	0.0	254.40	84.79	84.79	0.070
2	0.2000	0.2784	0.8698	0.3200	0.1881	0.264	0.053	254.17	99.31	84.72	0.070
3	0.3754	0.1547	0.8698	0.2239	0.3531	0.264	0.099	253.71	111.99	84.57	0.070
4	0.5370	0.1266	0.8698	0.1456	0.5051	0.265	0.142	253.37	123.73	84.45	0.069
5	0.6896	0.0525	0.8698	0.0603	0.6485	0.265	0.183	253.07	134.86	84.35	0.069
6	0.7412	0.0259	0.8698	0.0298	0.6971	0.265	0.196	252.93	138.61	84.30	0.069
7	0.7628	0.0139	0.8698	0.0159	0.7174	0.265	0.202	252.85	140.17	84.28	0.069
8	0.7700	0.0085	0.8698	0.0102	0.7242	0.265	0.204	252.81	140.69	84.26	0.069
9	*****	0.0	0.8813	0.0	*****	0.267	*****	251.11	*****	83.70	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.3 0.8 1.3 1.8

PHS A(IN. H2O): -1.220 -0.775 -0.445 -0.210 -0.035

PHS* A: -0.088 -0.056 -0.032 -0.015 -0.003

PHS E(IN. H2O): -1.110 -0.775 -0.445 -0.230 -0.060

PHS* E: -0.080 -0.056 -0.036 -0.017 -0.004

(a) S/D = 0.25

Table XIX. Four-Nozzle Performance Data for L/D = 3,
M_u = 0.068, Conical Transition.

DATA TAKEN 14 AUG 77 BY PETE HARRELL

FOUR NOZZLES, CONICAL TRANSITION, STANDOFF 0.0

4/2/3.0/0/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.72 INCHES HG

N RUN	POR (INCHES CF WATER)	OPCR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)	WS	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	12.5	10.0	154.0	154.0	75.0	6.50	5.03	5.03	0.0	0.264	254.22	84.73	84.73	0.070
2	12.6	10.0	154.0	154.0	75.0	7.60	3.97	3.97	0.785	0.264	253.88	99.23	84.62	0.070
3	14.8	10.0	154.0	154.0	75.0	8.70	2.79	2.79	1.767	0.265	253.49	112.07	84.49	0.070
4	15.8	10.0	154.0	154.0	75.0	9.70	1.80	1.80	3.142	0.265	253.17	123.77	84.29	0.069
5	16.7	10.0	154.0	154.0	75.0	10.60	0.73	0.73	6.284	0.265	252.77	134.41	84.25	0.069
6	17.1	10.0	154.0	154.0	75.0	11.00	0.37	0.37	9.621	0.265	252.66	138.52	84.22	0.069
7	17.1	10.0	154.0	154.0	75.0	11.10	0.19	0.19	13.548	0.265	252.55	139.35	84.18	0.069
8	17.2	10.0	154.0	154.0	75.0	11.10	0.13	0.13	17.081	0.265	252.54	140.60	84.18	0.069
9	17.4	10.0	149.0	149.0	75.0	11.30	0.0	0.0	*****	0.266	251.49	*****	83.83	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.0 0.3 0.8 1.3 1.8
 PMS A (IN. H2O): -1.390 -0.530 -0.550 -0.305 -0.060
 PMS A: -0.100 -0.067 -0.042 -0.022 -0.004
 PMS B (IN. H2O): -1.290 -0.505 -0.650 -0.330 -0.080
 PMS B: -0.093 -0.065 -0.047 -0.024 -0.006

(b) S/D = 0.0
 Table XIX. Continued.

DATA TAKEN 14 AUG 77 BY PETE FARRELL

FOUR NOZZLES, CONICAL TRANSITION, STANDOFF -0.25

4/2/3.0/-025/10

NUMBER OF PRIMARY NOZZLES: 4

PRIMARY NOZZLE DIAMETER: 0.966 INCHES

MIXING STACK LENGTH: 9.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.72 INCHES HG

N RUN	PCR (INCHES CF WATER)	CPCR	TOR	TUPT (DEGREES FAHRENHEIT)	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQUARE INCHES)
1	12.5	10.0	154.0	154.0	75.0	6.30	5.15	5.15	0.0
2	13.8	10.0	154.0	154.0	75.0	7.60	4.08	4.08	0.785
3	14.7	10.0	154.0	154.0	75.0	8.60	2.74	2.74	1.767
4	15.7	10.0	154.0	154.0	75.0	9.60	1.77	1.77	3.142
5	16.6	10.0	154.0	154.0	75.0	10.50	0.70	0.70	6.284
6	16.8	10.0	153.0	153.0	75.0	10.70	0.35	0.35	9.621
7	17.0	10.0	153.0	153.0	75.0	10.80	0.19	0.19	13.548
8	17.0	10.0	150.0	150.0	75.0	10.90	0.12	0.12	17.081
9	17.1	10.0	150.0	150.0	75.0	11.00	0.0	0.0	*****

N RUN	h*	p*	T*	P*/T*	M*/T*-44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3617	0.8713	0.4151	0.0	0.264	0.0	254.29	84.76	84.76	0.070
2	0.2029	0.2872	0.8713	0.3296	0.1909	0.264	0.054	254.01	99.48	84.66	0.070
3	0.3738	0.1537	0.8713	0.2224	0.3518	0.264	0.099	253.43	111.80	84.47	0.070
4	0.5336	0.1255	0.8713	0.1440	0.5022	0.265	0.141	253.12	123.42	84.37	0.069
5	0.6705	0.0498	0.8713	0.0571	0.6310	0.265	0.170	252.72	133.36	84.24	0.069
6	0.7199	0.0246	0.8727	0.0282	0.6780	0.265	0.191	252.35	136.91	84.11	0.069
7	0.7421	0.0132	0.8727	0.0151	0.6990	0.265	0.197	252.31	138.54	84.10	0.069
8	0.7517	0.0086	0.8770	0.0098	0.7095	0.266	0.200	251.65	139.16	83.08	0.069
9	*****	0.0	0.8770	0.0	*****	0.266	*****	251.61	*****	83.86	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/O: 0.0 C.3 0.8 1.3 1.8
PMS A (IN. P20): -1.480 -1.060 -0.710 -0.385 -0.075
PMS B (IN. P20): -1.380 -0.955 -0.745 -0.425 -0.110
PMS C (IN. P20): -0.099 -0.071 -0.053 -0.030 -0.008

(c) S/D = -0.25
Table XIX. Continued.

DATA TAKEN 13 AUG 77 BY PETE HARRELL

FOUR NOZZLES, NO TRANSITION, STANDOFF 0.5

4/0/3/050/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.73 INCHES HG

N	PCR	DPCR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA	UPT MACH
RUN	(INCHES CF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(SQARE INCHES)						
1	12.4	10.0	153.0	153.0	75.0	6.40	5.32	5.32	0.0	0.070
2	13.7	10.0	153.0	153.0	75.0	7.60	4.04	4.04	0.785	0.070
3	14.9	10.0	153.0	153.0	75.0	8.80	2.82	2.82	1.767	0.070
4	15.9	10.0	153.0	153.0	75.0	9.80	1.79	1.79	3.142	0.069
5	17.0	10.0	154.0	154.0	75.0	10.90	0.71	0.71	6.284	0.069
6	17.3	10.0	154.0	154.0	75.0	11.30	0.34	0.34	9.621	0.069
7	17.4	10.0	154.0	154.0	75.0	11.40	0.18	0.18	13.548	0.069
8	17.5	10.0	154.0	154.0	75.0	11.40	0.12	0.12	17.081	0.069
9	17.5	10.0	153.0	153.0	75.0	11.50	0.0	0.0	*****	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9
 X/D: 0.5 1.0 1.5 2.0 2.5
 PMS A (IN. P20): -2.390 -1.240 -0.560 -0.210 -0.080
 PMS A: -0.170 -0.080 -0.040 -0.015 -0.006
 PMS B (IN. H20): -2.160 -1.240 -0.675 -0.240 -0.100
 PMS B: -0.154 -0.056 -0.048 -0.017 -0.007

(a) S/D = 0.50

Table XX. Four-Nozzle Performance Data for L/D = 3,
 $M_u = 0.068$, Straight Entrance.

DATA TAKEN 13 AUG 77 BY PETE HARRELL

FOUR NOZZLES, NO TRANSITION, STANDOFF 0.25

4/0/3/025/10

NUMBER OF PRIMARY NOZZLES: 4

PRIMARY NOZZLE DIAMETER: 0.866 INCHES

MIXING STACK LENGTH: 9.00 INCHES

MIXING STACK DIAMETER: 3.00 INCHES

MIXING STACK L/D: 3.00

UPTAKE DIAMETER: 3.00 INCHES

AREA RATIO, AM/AP: 3.00

ORIFICE DIAMETER: 2.154 INCHES

ORIFICE BETA: 0.70

AMBIENT PRESSURE: 29.73 INCHES HG

N RUN	PCR (INCHES OF WATER)	OPCR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT (DEGREES FAHRENHEIT)	TAMB (DEGREES FAHRENHEIT)	PU-PA (LBM/SEC)	PA-PS (INCHES OF WATER)	PA-PNZ (INCHES OF WATER)	SECONDARY AREA (SQARE INCHES)	UU (FT/SEC)	UM (FT/SEC)	UP (FT/SEC)	WS (LBM/SEC)	WP (LBM/SEC)	UPT MACH
1	12.5	10.0	153.0	153.0	75.0	6.40	5.32	5.22	0.0	84.71	84.71	254.15	0.0	0.264	0.070
2	13.8	10.0	153.0	153.0	75.0	7.70	4.02	4.02	0.785	84.57	99.27	253.72	0.053	0.264	0.070
3	14.7	10.0	153.0	153.0	75.0	8.60	2.77	2.77	1.767	84.35	111.87	253.20	0.099	0.265	0.070
4	15.8	10.0	153.0	153.0	75.0	9.70	1.76	1.76	3.142	84.29	123.23	252.90	0.141	0.265	0.069
5	16.7	10.0	153.0	153.0	75.0	10.60	0.68	0.68	6.284	84.16	132.56	252.49	0.175	0.265	0.069
6	16.9	10.0	153.0	153.0	75.0	10.80	0.33	0.33	9.621	84.10	135.34	252.33	0.185	0.265	0.069
7	17.1	10.0	153.0	153.0	75.0	11.00	0.17	0.17	13.548	84.09	136.27	252.29	0.189	0.265	0.069
8	17.1	10.0	153.0	153.0	75.0	11.00	0.11	0.11	17.081	84.08	137.00	252.25	0.192	0.265	0.069
9	17.2	10.0	152.0	152.0	75.0	11.10	0.0	0.0	*****	84.00	*****	252.01	*****	0.266	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.5 1.0 1.5 2.0 2.5

PMS # (IN. H2O): -3.100 -1.640 -0.785 -0.260 -0.110

PMS* A: -0.222 -0.117 -0.056 -0.019 -0.008

PMS # (IN. H2O): -2.850 -1.690 -0.890 -0.305 -0.120

PMS* B: -0.204 -0.121 -0.064 -0.022 -0.009

(b) S/D = 0.25

Table XX. Continued.

DATA TAKEN 13 AUG 77 BY FETE HARRELL

FOUR NOZZLES, NO TRANSITION, STANDOFF 0.0

4/0/3/0/10

NUMBER OF PRIMARY NOZZLES: 4
 UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.73 INCHES HG

PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 9.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/D: 3.00

N RUN	PCR (INCHES OF WATER)	CPCR (INCHES OF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES CF WATER)	PA-PS (INCHES CF WATER)	PA-PNZ (INCHES CF WATER)	SECONDARY AREA (SQUARE INCHES)
1	12.5	10.0	153.0	153.0	75.0	6.40	5.15	5.15	0.0
2	13.6	10.0	153.0	153.0	75.0	7.50	3.91	3.91	0.785
3	14.3	10.0	153.0	153.0	75.0	8.20	2.50	2.50	1.767
4	14.8	10.0	153.0	153.0	75.0	8.70	1.44	1.44	3.142
5	15.1	10.0	153.0	153.0	75.0	9.10	0.51	0.51	6.284
6	15.2	10.0	153.0	153.0	75.0	9.10	0.23	0.23	9.621
7	15.3	10.0	153.0	153.0	75.0	9.20	0.13	0.13	13.548
8	15.3	10.0	153.0	153.0	75.0	9.20	0.08	0.08	17.081
9	15.4	10.0	153.0	153.0	75.0	9.30	0.0	0.0	*****

N RUN	h*	p*	T*	p*/T*	Wt/T*	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.2623	0.8727	0.4151	0.0	0.264	0.0	254.04	84.67	0.070
2	0.1565	0.2760	0.8727	0.3163	0.1869	0.264	0.052	253.59	84.52	0.070
3	0.3570	0.1774	0.8727	0.2033	0.3362	0.265	0.094	252.91	84.30	0.069
4	0.4615	0.1026	0.8727	0.1176	0.4535	0.265	0.127	252.39	84.13	0.069
5	0.5700	0.0361	0.8727	0.0414	0.5369	0.265	0.151	251.90	83.96	0.069
6	0.5889	0.0165	0.8727	0.0189	0.5547	0.265	0.156	251.76	83.91	0.069
7	0.6113	0.0090	0.8727	0.0103	0.5757	0.265	0.162	251.72	83.90	0.069
8	0.6165	0.0057	0.8727	0.0066	0.5807	0.265	0.163	251.69	83.89	0.069
9	*****	0.0	0.8727	0.0	*****	0.265	*****	251.67	*****	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9
 X/D: 0.5 1.0 1.5 2.0 2.5
 PMS A (IN. H2O): -2.630 -1.550 -0.705 -0.365 -0.115
 PMS B (IN. H2O): -2.620 -1.530 -0.685 -0.325 -0.125
 PMS C (IN. H2O): -2.610 -1.510 -0.665 -0.305 -0.105

(c) S/D = 0.0
 Table XX. Continued.

DATA TAKEN 14 AUG 77 BY PETE HARRELL

FOUR NOZZLES, NO TRANSITION, STANDOFF 0.5

4/0/2/050/10

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.74 INCHES HG

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/C: 2.00

N	POR	DPOR	TOR	TUPT	TAMB	PU-PA	PA-PS	PA-PNZ	SECONDARY AREA	UPT MACH
RUN	(INCHES CF WATER)	(DEGREES FAHRENHEIT)	(INCHES OF WATER)	(SQARE INCHES)						
1	12.5	10.0	153.0	153.0	75.0	6.40	5.40	5.40	0.0	0.070
2	13.8	10.0	153.0	153.0	75.0	7.70	3.96	3.96	0.785	0.070
3	15.0	10.0	153.0	153.0	75.0	8.90	2.73	2.73	1.767	0.070
4	15.9	10.0	153.0	153.0	75.0	9.80	1.70	1.70	3.142	0.069
5	17.0	10.0	153.0	153.0	75.0	10.90	0.68	0.68	6.284	0.069
6	17.4	10.0	153.0	153.0	75.0	11.20	0.33	0.33	9.621	0.069
7	17.5	10.0	153.0	153.0	75.0	11.40	0.18	0.18	13.548	0.069
8	17.5	10.0	153.0	153.0	75.0	11.50	0.11	0.11	17.081	0.069
9	17.5	10.0	153.0	153.0	75.0	11.50	0.0	0.0	*****	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.3 0.8 1.3 1.8
 PMS #1 IN. H2O: -2.420 -1.200 -0.590 -0.100
 PMS# A: -0.173 -0.086 -0.042 -0.007
 PMS B IN. H2O: -2.310 -1.240 -0.620 -0.125
 PMS# B: -0.165 -0.088 -0.044 -0.009

Table XXI. Four-Nozzle Performance Data for L/D = 2,
 $M_u = 0.068$, Straight Entrance.

(a) S/D = 0.50

DATA TAKEN 14 AUG 77 BY PETE FARRELL

FOUR NOZZLES, NO TRANSITION, STANDOFF 0.25 4/0/2/025/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/C: 2.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AM/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.74 INCHES HG

N RUN	PCR (INCHES CF WATER)	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES CF WATER)	PA-PS (INCHES CF WATER)	PA-PNZ (INCHES CF WATER)	SECONDARY AREA (SQUARE INCHES)
1	12.5	10.0	153.0	75.0	6.40	5.28	5.28	0.0
2	13.9	10.0	153.0	75.0	7.70	3.90	3.90	0.785
3	15.0	10.0	153.0	75.0	8.80	2.62	2.62	1.767
4	15.8	10.0	153.0	75.0	9.70	1.63	1.63	3.142
5	16.7	10.0	153.0	75.0	10.60	0.63	0.63	6.284
6	16.9	10.0	153.0	75.0	10.80	0.31	0.31	9.621
7	17.0	10.0	153.0	75.0	10.90	0.16	0.16	13.548
8	17.1	10.0	153.0	75.0	11.00	0.10	0.10	17.081
9	17.2	10.0	152.0	75.0	11.10	0.0	0.0	*****

N RUN	W*	P*	T*	P*/T*	W*P**44	WP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UU (FT/SEC)	UPT MACH
1	0.0	0.3712	0.8727	0.4253	0.0	0.264	0.0	254.08	84.69	0.070
2	0.1982	0.2751	0.8727	0.3153	0.1866	0.265	0.052	253.63	99.02	0.070
3	0.3651	0.1655	0.8727	0.2126	0.3439	0.265	0.097	253.15	111.09	0.070
4	0.5116	0.1158	0.8727	0.1327	0.4819	0.265	0.136	252.77	121.72	0.069
5	0.6329	0.0445	0.8727	0.0510	0.5961	0.265	0.168	252.41	130.53	0.069
6	0.6768	0.0217	0.8727	0.0249	0.6374	0.265	0.180	252.27	133.71	0.069
7	0.6902	0.0114	0.8727	0.0131	0.6500	0.265	0.183	252.21	134.68	0.069
8	0.6879	0.0071	0.8727	0.0082	0.6478	0.266	0.183	252.20	134.51	0.069
9	*****	0.0	0.8741	0.0	*****	0.266	*****	251.96	*****	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.3 C-8 1.3 1.8
 PMS A (IN. H2O): -2.810 -1.500 -0.790 -0.150
 PMS* A: -0.201 -0.107 -0.056 -0.011
 PMS B (IN. H2O): -2.810 -1.500 -0.825 -0.155
 PMS* B: -0.201 -0.107 -0.059 -0.011

(b) S/D = 0.25
 Table XXI. Continued.

DATA TAKEN 14 AUG 77 BY PETE HARRELL

FOUR NOZZLES, NO TRANSITION, STANDOFF 0.0

4/0/2/0/10

NUMBER OF PRIMARY NOZZLES: 4
 PRIMARY NOZZLE DIAMETER: 0.866 INCHES
 MIXING STACK LENGTH: 6.00 INCHES
 MIXING STACK DIAMETER: 3.00 INCHES
 MIXING STACK L/C: 2.00

UPTAKE DIAMETER: 3.00 INCHES
 AREA RATIO, AH/AP: 3.00
 ORIFICE DIAMETER: 2.154 INCHES
 ORIFICE BETA: 0.70
 AMBIENT PRESSURE: 29.74 INCHES HG

N RUN	PUR (INCHES CF WATER)	DPCR	TOR (DEGREES FAHRENHEIT)	TUPT	TAMB	PU-PA (INCHES OF WATER)	PA-PS (INCHES OF WATER)	PA-PNZ	SECONDARY AREA (SQUARE INCHES)	MP (LBM/SEC)	WS (LBM/SEC)	UP (FT/SEC)	UM (FT/SEC)	UU (FT/SEC)	UPT MACH
1	12.5	10.0	153.0	153.0	75.0	6.40	5.00	5.00	0.0	0.264	0.0	253.90	84.63	84.63	0.070
2	13.8	10.0	153.0	153.0	75.0	7.70	3.64	3.64	0.785	0.264	0.051	253.43	98.46	84.47	0.070
3	14.5	10.0	153.0	153.0	75.0	8.40	2.21	2.21	1.767	0.265	0.089	252.74	108.78	84.24	0.069
4	15.0	10.0	153.0	153.0	75.0	8.80	1.21	1.21	3.142	0.265	0.117	252.27	116.36	84.08	0.069
5	15.1	10.0	153.0	153.0	75.0	9.00	0.42	0.42	6.284	0.265	0.137	251.80	121.74	83.53	0.069
6	15.1	10.0	153.0	153.0	75.0	9.00	0.19	0.19	9.621	0.265	0.142	251.66	123.05	83.88	0.069
7	15.1	10.0	153.0	153.0	75.0	9.00	0.10	0.10	13.548	0.265	0.145	251.60	123.88	83.86	0.069
8	15.1	10.0	153.0	153.0	75.0	9.00	0.06	0.06	17.081	0.265	0.141	251.58	122.93	83.85	0.069
9	15.1	10.0	150.0	150.0	75.0	9.00	0.0	0.0	*****	0.266	*****	250.92	*****	83.64	0.069

MIXING STACK PRESSURE DISTRIBUTIONS FOR RUN: 9

X/D: 0.3 0.8 1.3 1.8
 PMS A (IN. F20): -2.530 -1.210 -0.775 -0.200
 PMS A: -0.182 -0.094 -0.056 -0.014
 PMS B (IN. H20): -2.710 -1.540 -0.735 -0.125
 PMS B: -0.195 -0.111 -0.053 -0.009

(c) S/D = 0.0
 Table XXI. Continued.

DATA TAKEN 9 AUG 77 BY FETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0, L/D = 7.57

AMBIENT PRESSURE = 29.77 IN.HGA, TEMPERATURE = 73.0 DEG.FAHR

PRIMARY (UPTAKE) TEMPERATURE = 151.0 DEG.FAHR

DIAMETRIC POSITION (INCHES)	RADIUS (INCHES)	PTA (IN.H2O)	PTB (IN.H2O)	VA (FT/SEC)	VB (FT/SEC)	VA/VAVG	VB/VAVG
0.075	1.425	3.40	3.40	129.0	129.0	0.89	0.89
0.225	1.275	4.20	4.10	143.4	141.7	0.99	0.98
0.375	1.125	4.50	4.30	148.4	145.1	1.03	1.01
0.525	0.975	4.60	4.50	150.1	148.4	1.04	1.03
0.675	0.825	4.70	4.60	151.7	150.1	1.05	1.04
0.825	0.675	4.80	4.60	153.3	150.1	1.06	1.04
0.975	0.525	4.90	4.80	154.9	153.3	1.07	1.06
1.125	0.375	4.90	5.00	154.9	156.5	1.07	1.08
1.275	0.225	5.00	5.00	156.5	156.5	1.08	1.08
1.425	0.075	5.00	5.10	156.5	158.0	1.08	1.10
1.575	0.075	5.00	5.10	156.5	158.0	1.08	1.10
1.725	0.225	5.00	5.10	156.5	158.0	1.08	1.10
1.875	0.375	4.90	5.00	154.9	156.5	1.07	1.08
2.025	0.525	4.90	4.90	154.9	154.9	1.07	1.07
2.175	0.675	4.80	4.80	153.3	153.3	1.06	1.06
2.325	0.825	4.70	4.60	151.7	150.1	1.05	1.04
2.475	0.975	4.60	4.50	150.1	148.4	1.04	1.03
2.625	1.125	4.40	4.20	146.8	143.4	1.02	0.99
2.775	1.275	4.10	3.80	141.7	136.4	0.98	0.95
2.925	1.425	3.20	2.90	125.2	119.2	0.87	0.83

INTEGRATED VOLUMETRIC FLOW RATE = 7.08 CU.FT/SEC

INTEGRATED MASS FLOW RATE = 0.484 LBM/SEC

AVERAGE VELOCITY = 144.28 FT/SEC

MOMENTUM FACTOR, K_M = 1.005

PRIMARY VELOCITY AT NOZZLE EXIT = 251.64

(a) L/D = 7.57

Table XXII. Mixing Stack Exit Velocity Profile Data for Four Nozzles,
 $M_u = 0.068$, Elliptic Transition.

DATA TAKEN 11 AUG 77 BY PETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0, L/D = 5.57

AMBIENT PRESSURE = 29.71 IN.HGA, TEMPERATURE = 73.0 DEG.FAHR
 PRIMARY (UPTAKE) TEMPERATURE = 152.0 DEG.FAHR

DIAMETRIC POSITION (INCHES)	RADIALS (INCHES)	PTA (IN.H2O)	PTB (IN.H2O)	VA (FT/SEC)	VB (FT/SEC)	VA/VAVG	VB/VAVG
0.075	1.425	3.80	3.00	136.6	121.4	0.94	0.84
0.225	1.275	4.30	3.40	145.3	129.2	1.00	0.89
0.375	1.125	4.50	3.60	148.6	133.0	1.03	0.92
0.525	0.975	4.70	3.90	151.9	138.4	1.05	0.95
0.675	0.825	5.10	4.20	158.2	143.6	1.09	0.99
0.825	0.675	5.10	4.50	158.2	148.6	1.09	1.03
0.975	0.525	5.10	4.90	158.2	155.1	1.09	1.07
1.125	0.375	5.10	5.10	158.2	158.2	1.09	1.09
1.275	0.225	5.10	5.10	158.2	158.2	1.09	1.09
1.425	0.075	5.10	5.10	158.2	158.2	1.09	1.09
1.575	0.075	5.10	5.10	158.2	158.2	1.09	1.09
1.725	0.225	5.10	5.10	158.2	158.2	1.09	1.09
1.875	0.375	5.10	5.10	158.2	158.2	1.09	1.09
2.025	0.525	5.10	4.90	158.2	155.1	1.09	1.07
2.175	0.675	5.10	4.60	158.2	150.3	1.09	1.04
2.325	0.825	5.20	4.40	159.8	147.0	1.10	1.01
2.475	0.975	5.10	4.20	158.2	143.6	1.09	0.99
2.625	1.125	5.00	4.10	156.7	141.9	1.08	0.98
2.775	1.275	4.50	3.90	148.6	138.4	1.03	0.95
2.925	1.425	3.60	3.00	133.0	121.4	0.92	0.84

INTEGRATED VOLUMETRIC FLOW RATE = 7.12 CU.FT/SEC

INTEGRATED MASS FLOW RATE = 0.485 LBM/SEC

AVERAGE VELOCITY = 144.99 FT/SEC

MOMENTUM FACTOR, KP = 1.006

PRIMARY VELOCITY AT NOZZLE EXIT = 252.11

(b) L/D = 5.57

Table XXII. Continued.

CATA TAKEN 12 AUG 77 BY PETE HARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0, L/D = 4.57

AMBIENT PRESSURE = 29.71 IN.HGA, TEMPERATURE = 72.0 DEG.FAHR

PRIMARY (UPTAKE) TEMPERATURE = 150.0 DEG.FAHR

DIAMETRIC POSITION (INCHES)	RACILS (INCHES)	PTA (IN.H2O)	PTB (IN.H2O)	VA (FT/SEC)	VB (FT/SEC)	VA/VAVG	VB/VAVG
0.075	1.425	3.20	2.30	125.2	106.1	0.87	0.74
0.225	1.275	3.70	3.00	134.6	121.2	0.94	0.84
0.375	1.125	4.20	3.30	143.4	127.1	1.00	0.88
0.525	0.975	4.70	3.60	151.7	132.8	1.05	0.92
0.675	0.825	5.10	4.00	158.0	140.0	1.10	0.97
0.825	0.675	5.40	4.50	162.6	148.4	1.13	1.03
0.975	0.525	5.50	4.90	164.1	154.9	1.14	1.08
1.125	0.375	5.50	5.10	164.1	158.0	1.14	1.10
1.275	0.225	5.30	5.20	161.1	159.6	1.12	1.11
1.425	0.075	5.20	5.20	159.6	159.6	1.11	1.11
1.575	0.075	5.20	5.10	159.6	158.0	1.11	1.10
1.725	0.225	5.10	5.00	158.0	156.5	1.10	1.09
1.875	0.375	5.10	5.00	158.0	156.5	1.10	1.09
2.025	0.525	5.20	4.90	159.6	154.9	1.11	1.08
2.175	0.675	5.30	4.70	161.1	151.7	1.12	1.05
2.325	0.825	5.30	4.40	161.1	146.8	1.12	1.02
2.475	0.975	5.20	4.20	159.6	143.4	1.11	1.00
2.625	1.125	5.20	4.00	159.6	140.0	1.11	0.97
2.775	1.275	4.80	3.90	153.3	138.2	1.07	0.96
2.925	1.425	4.20	3.50	143.4	130.9	1.00	0.91

INTEGRATED VOLUMETRIC FLOW RATE = 7.06 CU.FT/SEC

INTEGRATED MASS FLOW RATE = 0.483 LBM/SEC

AVERAGE VELOCITY = 143.85 FT/SEC

MOMENTUM FACTOR, KP = 1.010

PRIMARY VELOCITY AT NOZZLE EXIT = 251.70

(c) L/D = 4.57

Table XXII. Continued.

DATA TAKEN 19 AUG 77 BY PETE FARRELL

FOUR NOZZLES, ELLIPTIC TRANSITION, STANDOFF 0.0, L/D = 3

AMBIENT PRESSURE = 29.83 IN.HGA, TEMPERATURE = 74.0 DEG.FAHR

PRIMARY (UPTAKE) TEMPERATURE = 152.0 DEG.FAHR

DIAMETRIC POSITION (INCHES)	RADIALS (INCHES)	PTA (IN.H2O)	PTB (IN.H2O)	VA (FT/SEC)	VB (FT/SEC)	VA/VAVG	VB/VAVG
0.075	1.425	3.20	1.30	125.1	79.8	0.89	0.57
0.225	1.275	3.50	1.60	138.2	88.5	0.98	0.63
0.375	1.125	5.10	1.90	158.0	96.4	1.13	0.69
0.525	0.975	6.60	2.60	179.7	112.8	1.28	0.90
0.675	0.825	7.10	3.70	186.4	134.6	1.33	0.96
0.825	0.675	7.00	4.40	185.1	146.7	1.32	1.05
0.975	0.525	6.40	5.00	177.0	156.4	1.26	1.12
1.125	0.375	5.70	5.30	167.0	161.1	1.19	1.15
1.275	0.225	5.00	4.90	156.4	154.9	1.12	1.10
1.425	0.075	4.60	4.60	150.0	150.0	1.07	1.07
1.575	0.075	4.60	4.60	150.0	150.0	1.07	1.07
1.725	0.225	4.80	4.60	153.3	150.0	1.09	1.07
1.875	0.375	5.20	4.90	159.5	154.9	1.14	1.10
2.025	0.525	5.90	5.00	169.9	156.4	1.21	1.12
2.175	0.675	6.50	4.70	178.4	151.7	1.27	1.08
2.325	0.825	7.00	4.10	185.1	141.7	1.32	1.01
2.475	0.975	7.10	3.50	186.4	130.9	1.33	0.93
2.625	1.125	6.40	2.80	177.0	117.1	1.26	0.83
2.775	1.275	4.90	2.20	154.9	103.8	1.10	0.74
2.925	1.425	3.90	1.90	138.2	96.4	0.98	0.69

INTEGRATED VOLUMETRIC FLOW RATE = 6.89 CU.FT/SEC

INTEGRATED MASS FLOW RATE = 0.471 LBM/SEC

AVERAGE VELOCITY = 140.28 FT/SEC

MOMENTUM FACTOR, KM = 1.038

PRIMARY VELOCITY AT NOZZLE EXIT = 251.58

(d) L/D = 3.0

Table XXII. Continued.

DATA TAKEN 15 AUG 77 BY PETE HARRELL

FOUR NOZZLES, CONICAL TRANSITION, STANDOFF 0.0, L/D = 4.0

AMBIENT PRESSURE = 29.63 IN.HGA, TEMPERATURE = 74.0 DEG.FAHR

PRIMARY (UPTAKE) TEMPERATURE = 153.0 DEG.FAHR

DIAMETRIC POSITION (INCHES)	RADIUS (INCHES)	PTA (IN.H2O)	PTB (IN.H2O)	VA (FT/SEC)	VB (FT/SEC)	VA/VAVG	VB/VAVG
0.075	1.425	3.00	1.60	121.6	88.8	0.86	0.63
0.225	1.275	3.60	2.40	133.2	108.8	0.94	0.77
0.375	1.125	4.60	2.60	150.6	113.2	1.06	0.80
0.525	0.975	5.40	3.00	163.2	121.6	1.15	0.86
0.675	0.825	5.70	3.50	167.7	131.4	1.18	0.93
0.825	0.675	5.80	4.00	169.1	140.5	1.19	0.99
0.975	0.525	5.60	4.50	166.2	149.0	1.17	1.05
1.125	0.375	5.30	4.80	161.7	153.9	1.14	1.08
1.275	0.225	5.10	4.90	158.6	155.5	1.12	1.09
1.425	0.075	4.90	4.80	155.5	153.9	1.09	1.08
1.575	0.075	4.80	4.70	153.9	152.3	1.08	1.07
1.725	0.225	4.80	4.70	153.9	152.3	1.08	1.07
1.875	0.375	5.00	4.80	157.0	153.9	1.11	1.08
2.025	0.525	5.20	4.80	160.1	153.9	1.13	1.08
2.175	0.675	5.50	4.70	164.7	152.3	1.16	1.07
2.325	0.825	5.70	4.40	167.7	147.3	1.18	1.04
2.475	0.975	5.70	4.20	167.7	143.9	1.18	1.01
2.625	1.125	5.50	4.00	164.7	140.5	1.16	0.99
2.775	1.275	5.10	3.70	158.6	135.1	1.12	0.95
2.925	1.425	4.10	3.00	142.2	121.6	1.00	0.86

INTEGRATED VOLUMETRIC FLOW RATE = 6.97 CU.FT/SEC

INTEGRATED MASS FLOW RATE = 0.473 LBM/SEC

AVERAGE VELOCITY = 142.03 FT/SEC

MOMENTUM FACTOR, KM = 1.018

PRIMARY VELOCITY AT NOZZLE EXIT = 252.60

(a) L/D = 4.0

Table XXIII. Mixing Stack Exit Velocity Profile Data for Four Nozzles, :
 $M_u = 0.068$, Conical Transition.

DATA TAKEN 14 AUG 77 BY PETE HARRELL

FOUR NOZZLES, CONICAL TRANSITION, STANDOFF 0.0, L/D = 3.0

AMBIENT PRESSURE = 29.72 IN.HGA, TEMPERATURE = 74.0 DEG.FAHR

PRIMARY (UPTAKE) TEMPERATURE = 153.0 DEG.FAHR

DIAMETRIC POSITION (INCHES)	RADIUS (INCHES)	PTA (IN.H2O)	PTB (IN.H2O)	VA (FT/SEC)	VB (FT/SEC)	VA/VAVG	VB/VAVG
0.075	1.425	1.90	1.70	96.7	91.4	0.68	0.65
0.225	1.275	4.00	2.30	140.2	106.3	0.99	0.75
0.375	1.125	5.10	2.50	158.4	110.9	1.12	0.78
0.525	0.975	6.50	3.10	178.8	123.5	1.26	0.87
0.675	0.825	7.20	3.90	188.2	138.5	1.33	0.98
0.825	0.675	7.20	4.70	188.2	152.0	1.33	1.07
0.975	0.525	6.60	5.20	180.1	159.9	1.27	1.13
1.125	0.375	5.80	5.20	168.9	159.9	1.19	1.13
1.275	0.225	5.00	4.80	156.8	153.6	1.11	1.09
1.425	0.075	4.50	4.50	148.7	148.7	1.05	1.05
1.575	0.075	4.40	4.30	147.1	145.4	1.04	1.03
1.725	0.225	4.50	4.40	148.7	147.1	1.05	1.04
1.875	0.375	4.90	4.60	155.2	150.4	1.10	1.06
2.025	0.525	5.60	4.80	165.9	153.6	1.17	1.09
2.175	0.675	6.40	4.50	177.4	148.7	1.25	1.05
2.325	0.825	7.00	3.80	185.5	136.7	1.31	0.97
2.475	0.975	7.30	3.10	189.5	123.5	1.34	0.87
2.625	1.125	6.40	2.60	177.4	113.1	1.25	0.80
2.775	1.275	5.40	2.30	162.9	106.3	1.15	0.75
2.925	1.425	4.00	1.90	140.2	96.7	0.99	0.68

INTEGRATED VOLUMETRIC FLOW RATE = 6.94 CU.FT/SEC

INTEGRATED MASS FLOW RATE = 0.473 LBM/SEC

AVERAGE VELOCITY = 141.42 FT/SEC

MOMENTUM FACTOR, KH = 1.036

PRIMARY VELOCITY AT NOZZLE EXIT = 252.24

(b) L/D = 3.0

Table XXIII. Continued.

DATA TAKEN 13 AUG 77 BY PETE HARRELL

FOUR NOZZLES, NO TRANSITION, STANDOFF 0.0, L/D = 3

AMBIENT PRESSURE = 29.73 IN.HGA, TEMPERATURE = 71.0 DEG.FAHR

PRIMARY (UPTAKE) TEMPERATURE = 152.0 DEG.FAHR

DIAMETRIC POSITION (INCHES)	RADIALS (INCHES)	PTA (IN.H2O)	PTB (IN.H2O)	VA (FT/SEC)	VB (FT/SEC)	VA/VAVG	VB/VAVG
0.075	1.425	4.20	2.30	143.4	106.1	1.14	0.85
0.225	1.275	5.10	2.70	158.1	115.0	1.26	0.92
0.375	1.125	5.10	2.70	158.1	115.0	1.26	0.92
0.525	0.975	4.50	2.70	148.5	115.0	1.18	0.92
0.675	0.825	3.70	2.60	134.6	112.9	1.07	0.90
0.825	0.675	2.80	2.40	117.1	108.4	0.93	0.86
0.975	0.525	2.20	2.20	103.8	103.8	0.83	0.83
1.125	0.375	1.70	1.80	91.3	93.9	0.73	0.75
1.275	0.225	1.30	1.70	79.8	91.3	0.64	0.73
1.425	0.075	1.00	1.40	70.0	82.8	0.56	0.66
1.575	0.075	1.10	1.40	73.4	82.8	0.58	0.66
1.725	0.225	1.50	1.60	85.7	88.5	0.68	0.71
1.875	0.375	1.50	1.60	85.7	88.5	0.68	0.71
2.025	0.525	1.90	2.10	96.5	101.4	0.77	0.81
2.175	0.675	2.90	2.70	119.2	115.0	0.95	0.92
2.325	0.825	3.50	2.90	130.9	119.2	1.04	0.95
2.475	0.975	4.30	3.20	145.1	125.2	1.16	1.00
2.625	1.125	4.70	3.40	151.7	129.1	1.21	1.03
2.775	1.275	4.70	3.60	151.7	132.8	1.21	1.06
2.925	1.425	4.20	3.30	143.4	127.1	1.14	1.01

INTEGRATED VOLUMETRIC FLOW RATE = 6.16 CU.FT/SEC

INTEGRATED MASS FLOW RATE = 0.421 LBM/SEC

AVERAGE VELOCITY = 125.51 FT/SEC

MOMENTUM FACTOR, KM = 1.022

PRIMARY VELOCITY AT NOZZLE EXIT = 251.27

(a) L/D = 3.0

Table XXIV. Mixing Stack Exit Velocity Profile Data for Four Nozzles,
 $M_u = 0.068$, Straight Entrance.

DATA TAKEN 14 AUG 77 BY PETE HARRELL

FOUR NOZZLES, NO TRANSITION, STANDOFF 0.0, L/D = 2

AMBIENT PRESSURE = 29.74 IN.HGA, TEMPERATURE = 74.0 DEG.FAHR

PRIMARY (UPTAKE) TEMPERATURE = 146.0 DEG.FAHR

DIAMETRIC POSITION (INCHES)	RADIUS (INCHES)	PTA (IN.H2O)	PTB (IN.H2O)	VA (FT/SEC)	VB (FT/SEC)	VA/VAVG	VB/VAVG
0.075	1.425	4.20	1.70	143.2	91.1	1.22	0.77
0.225	1.275	5.50	1.60	163.9	88.4	1.39	0.75
0.375	1.125	7.10	1.60	186.2	88.4	1.58	0.75
0.525	0.975	7.30	1.50	188.8	85.6	1.60	0.73
0.675	0.825	5.50	1.50	163.9	85.6	1.39	0.73
0.825	0.675	3.70	1.30	134.4	79.7	1.14	0.68
0.975	0.525	2.10	1.10	101.2	73.3	0.86	0.62
1.125	0.375	1.00	0.80	69.9	62.5	0.59	0.53
1.275	0.225	0.50	0.50	49.4	49.4	0.42	0.42
1.425	0.075	0.30	0.30	38.3	38.3	0.32	0.32
1.575	0.075	0.30	0.30	38.3	38.3	0.32	0.32
1.725	0.225	0.50	0.50	49.4	49.4	0.42	0.42
1.875	0.375	1.00	0.80	69.9	62.5	0.59	0.53
2.025	0.525	1.90	1.10	96.3	73.3	0.82	0.62
2.175	0.675	3.50	1.70	130.7	91.1	1.11	0.77
2.325	0.825	5.40	1.90	162.4	96.3	1.38	0.82
2.475	0.975	7.00	1.90	184.9	96.3	1.57	0.82
2.625	1.125	7.00	1.90	184.9	96.3	1.57	0.82
2.775	1.275	5.50	1.90	163.9	96.3	1.39	0.82
2.925	1.425	4.10	1.70	141.5	91.1	1.20	0.77

INTEGRATED VOLUMETRIC FLOW RATE = 5.78 CU.FT/SEC

INTEGRATED MASS FLOW RATE = 0.397 LBM/SEC

AVERAGE VELOCITY = 117.82 FT/SEC

MOMENTUM FACTOR, KM = 1.083

PRIMARY VELOCITY AT NOZZLE EXIT = 250.11

(b) L/D = 2.0

Table XXIV. Continued.

APPENDIX A

CALCULATION OF THE MOMENTUM CORRECTION FACTOR

The momentum correction factor is defined as the ratio of the actual momentum rate to the rate based on the bulk-average velocity. Defining the actual momentum as that obtained by integrating over the velocity surface, the momentum correction factor may be written as

$$K_m = \frac{1}{W_m U_m} \int_0^{A_m} U^2 \rho_2 dA . \quad (4)$$

The density of the air at the mixing stack exit ρ_2 is a weighted average of the densities of the primary and secondary air flows. Assuming a secondary to primary mass flow rate ratio of 0.65, which is consistent with experimental results, ρ_2 is expressed as

$$\rho_2 = \rho_{avg.} = \frac{\rho_s}{1.65} \left[0.65 + \frac{T_s}{T_p} \right] . \quad (a)$$

Using this average density of the mixed flow, the mass flow rate leaving the mixing stack may be expressed as

$$W_m = \rho_{avg.} U_m A_m . \quad (b)$$

Combining equations (4) and (b) results in an equation for the momentum correction factor in terms of the experimentally

determined mixing stack exit velocity profiles,

$$K_m = \frac{1}{U_m^2 A_m} \int_0^{A_m} U_2^2 dA . \quad (c)$$

Figure 40 illustrates the orientation of the two velocity traverses.

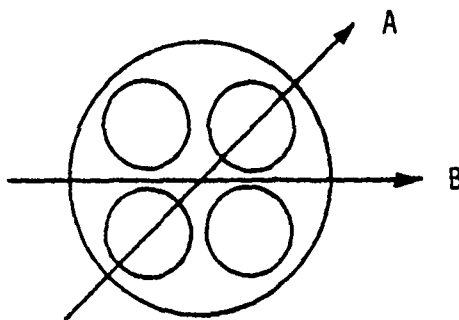


FIGURE 40. Orientation of Mixing Stack Exit Velocity Traverses

To integrate the mixing stack exit velocity over the three-dimensional velocity surface using only the two traverses requires some approximations:

1. Traverses A and B represent the maximum and minimum values of the velocity surface respectively.
2. The three-dimensional velocity surface is symmetrical, i.e. a velocity traverse passing above the other two primary nozzles, perpendicular to traverse A, is equal to that of traverse A and likewise for traverse B.

3. The circumferential variation of the velocity surface is sinusoidal with the maximum and minimum values at a given radius occurring at traverses A and B respectively.

The velocity traverse obtained experimentally consists of discrete points rather than a continuous curve. Each of these point values of velocity is representative of a radial element of the velocity traverse of length equal to the spacing between successive points. The procedure is to fit a circumferential sinusoidal curve through the maximum and minimum velocities of traverses A and B respectively. This circumferential band is then treated as a segment of the velocity surface of incremental width dr equal to the spacing between the data points and is integrated circumferentially over successive radial elements. Completion of the integration yields the actual momentum of the mixed gases leaving the exit of the mixing stack.

APPENDIX B

UNCERTAINTY ANALYSIS

The experimentally determined pressure coefficient and pumping coefficient are used in determining eductor operating points which in turn provide the basis for comparison and evaluation of eductor system performance. A determination of the uncertainties in these coefficients was made using the method described by Kline and McClintock [7]. Data for the eductor configuration described in Table VIIb is considered a representative case and is used to calculate representative uncertainties in the pumping and pressure coefficients.

For a single sample measurement the value of a specific variable should be given in the format:

$$x = \bar{x} \pm \delta x$$

where

\bar{x} = mean value of the variable x

δx = estimated uncertainty in x .

Variations for the variables in the defining equations for the two coefficients are listed at the end of this appendix. Having described the uncertainties in the basic variables

of a relationship, it is now necessary to determine how these uncertainties propagate into the result. Consider the relation where the result R is the product of a sequence of terms.

$$R = x_1^a x_2^b x_3^c \quad (a)$$

A reasonable prediction of the uncertainty in the result R is obtained by using the Second Order Equation suggested by Kline and McClintock [6].

$$\delta R = \left[\left(\frac{\partial R}{\partial x_1} \delta x_1 \right)^2 + \left(\frac{\partial R}{\partial x_2} \delta x_2 \right)^2 + \left(\frac{\partial R}{\partial x_3} \delta x_3 \right)^2 \right]^{1/2} \quad (b)$$

Evaluating the partial derivatives appearing in equation (b) and normalizing by dividing through by R yields the simplified form of equation (b) which will be used in this analysis.

$$\frac{\delta R}{R} = \left[\left(\frac{a \delta x_1}{x_1} \right)^2 + \left(\frac{b \delta x_2}{x_2} \right)^2 + \left(\frac{c \delta x_3}{x_3} \right)^2 \right]^{1/2} \quad (c)$$

Determination of the uncertainty in the pressure coefficient is facilitated by writing it as the product of a series of terms,

$$\frac{\Delta P^*}{T^*} = (\rho_s)^{-1} (\Delta P) (U_p)^{-2} (T^*)^{-1} \quad (d)$$

where ΔP represents the pressure difference ($P_a - P_0$). Constants such as $2 g_c$ in the equation for the pressure coefficient will be cancelled out when used in equation (c) and are therefore not included in this analysis. Applying equation (c) to the pumping coefficient in equation (d) yields the following expression for its uncertainty:

$$\frac{\delta \frac{\Delta P^*}{T^*}}{\frac{\Delta P^*}{T^*}} = \left[\left(\frac{(-1) \delta \rho_s}{\rho_s} \right)^2 + \left(\frac{(-1) \delta (\Delta P)}{\Delta P} \right)^2 + \left(\frac{(-2) \delta U_p}{U_p} \right)^2 + \left(\frac{(-1) \delta T^*}{T^*} \right)^2 \right]^{1/2} \quad (e)$$

Taking into account the respective equations defining the individual variables, the terms of equation (e) are expanded as follows:

$$\rho_s = \frac{P_a}{R T_s}, \quad \left[\frac{\delta \rho_s}{\rho_s} \right]^2 = \left[\frac{\delta P_a}{P_a} \right]^2 + \left[\frac{\delta T_s}{T_s} \right]^2$$

$$U_p^2 = \frac{2 g_c P_v}{\rho_p} = \frac{2 g_c R P_v T_p}{P_u},$$

$$\left[\frac{(-2) \delta U_p}{U_p} \right]^2 = \left[\frac{(-2) \delta P_v}{P_v} \right]^2 + \left[\frac{(-2) \delta T_p}{T_p} \right]^2$$

$$+ \left[\frac{(-2) \delta P_u}{P_u} \right]^2$$

$$T^* = \frac{T_s}{T_p}, \quad \left[\frac{\delta T^*}{T^*} \right]^2 = \left[\frac{\delta T_s}{T_s} \right]^2 + \left[\frac{\delta T_p}{T_p} \right]^2$$

Using the values of the variables and their respective uncertainties listed in Table XXV, the uncertainty in the pressure coefficient is estimated to be

$$\frac{\delta \left(\frac{\Delta P^*}{T^*} \right)}{\frac{\Delta P^*}{T^*}} = 0.005 = \pm 0.5\%$$

By a similar process, the uncertainty in the pumping coefficient is estimated to be

$$\frac{\delta (W^* T^{*.44})}{W^* T^{*.44}} = 0.028 = \pm 2.8\%$$

<u>VARIABLE</u>	<u>VALUE</u>	<u>UNCERTAINTY</u>
T_s	530 °R	± 1 °R
T_p	597 °R	± 1 °R
P_a	14.72 psia	± 0.01 psia
ΔP	0.12 in. H_2O	± 0.005 in. H_2O
P_v	0.98 in. H_2O	± 0.01 in. H_2O
P_u	9.6 in. H_2O	± 0.1 in. H_2O
$\Delta P_s (\dagger), (\dagger\dagger)$	0.12 in. H_2O	± 0.005 in. H_2O
$P_{or} (\dagger)$	15.6 in. H_2O	± 0.1 in. H_2O
$\Delta P_{or} (\dagger)$	10.0 in. H_2O	± 0.1 in. H_2O
$T_{or} (\dagger)$	597 °R	± 1 °R

(\dagger) These quantities were used in calculation of the uncertainty in the pumping coefficient.

($\dagger\dagger$) The pressure differential across the secondary flow nozzles ΔP_s is zero at the operating point. It is the major source of uncertainty in the pumping coefficient, however, and is therefore included here with a representative value.

Table XXV. Variables With Corresponding Uncertainties
Taken from Table VII(b)

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